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ABSTRACT

In this set of five booklets on measuring, primary grade students learn how to use a stopwatch, choose the correct tool to measure distance, use a trundle wheel, make a scale drawing, and find the speed of things. The major emphasis in all Unified Sciences and Mathematics for Elementary Schools (USMES) units is on open-ended, long-range investigations of real problems. In most instances students learn through observing results of their own and their classmates' experiments. However, students may recognize the need for certain facts and/or skills during their investigations. Although some children prefer to work things out for themselves, others may ask for help. USMES "How To Sets" are designed to provide such assistance. Each booklet in a set contains several examples of children using a skill being taught, each example emphasizing a different aspect of the skill or a potential pitfall. Cover pages summarize what is being taught by illustrating the general problem and solution. There is no sequence to the sets (or booklets within sets) and they should not be used out of the context of childrens' open investigation of a practical problem. (Author/JN)

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# HOW TO SET MEASURING

IN THIS SET STUDENTS WILL FIND OUT HOW TO ...

USE A STOPWATCH

CHOOSE THE RIGHT TOOL TO MEASURE DISTANCE

USE A TRUNDLE WHEEL

MAKE A SCALE DRAWING

FIND THE SPEED OF THINGS

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# WHAT IS USMES?

USMES challenges students to solve real problems within their school and community. Children tackle problems like a busy or unsafe intersection near their school, classroom furniture that doesn't fit them, or playgrounds that are crowded or uninteresting. These problems have immediate and practical impact on students. They have no established, correct solutions--students take or recommend action based upon whatever data they collect and analyze. Furthermore, the children themselves, not the teacher, direct the problem-solving process.

Solving real problems is interdisciplinary: skills, processes, and concepts from science, mathematics, social science, and language arts all play a part. For example, students conduct opinion surveys, build measuring devices, write letters, and make and use graphs. They also make decisions, work productively in small groups, and develop and clarify values.

The USMES curriculum is organized into twenty-six problems, or units, that have been developed in the classroom by teachers and students in a wide variety of schools. Most units can be used in grades K-8 although the level at which students approach a problem and develop a solution will vary according to age, ability, and interest.

# RESOURCES FOR AN USMES PROGRAM

In addition to the USMES "How To" Series, there are--

*The USMES Guide:* This book describes the USMES project, real problem solving, classroom strategies, the Design Lab, the units, and the support materials as well as ways that USMES helps students learn basic skills.

*Teacher Resource Books* (one per unit): Each of these guides to using USMES units describes a broad problem, explains how students might narrow that problem to meet their particular needs, recommends classroom strategies, and presents logs from teachers whose classes have worked on the unit.

*Design Lab Manual:* This guide helps teachers and administrators set up, run, and use a Design Lab--a place with tools and materials where students can build things they need for their work on USMES units. A Design Lab may be a corner of a classroom, a portable cart, or a separate room.

*Background Papers:* These papers, correlated with the "How To" Series, provide teachers with information and hints that do not appear in the student materials.

*Curriculum Correlation Guide:* By correlating the twenty-six USMES units with other curriculum materials, this book helps teachers integrate USMES with other school activities and lessons.

The "How To" Series is a resource developed by the USMES project. Earle L. Lomon, Project Director, Betty M. Beck, Associate Director for Development, Eugene C. Brown, Associate Director for Dissemination Studies, Quinton E. Baker, Associate Director for Administration.

This material is based upon research supported by the National Science Foundation under Grant No. SED69-01071. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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Complete USMES Library ISBN 0-89292-033-5
Beginning "How-To" Series ISBN 0-89292-029-7

# THE USMES BEGINNING "HOW TO" SERIES

## USMES and Skills

USMES students often see a need to learn new skills to help them get a problem-solving job done. Children seeking to improve a street crossing may want to learn how to use a stopwatch or how to make a trundle wheel. Children comparing different brands of paper towels may want to learn how to design an experiment and how to make a bar graph. The list can go on and on, but the pattern is clear; solving a real problem requires skills.

## Purpose of 'How To' Series

Written resources that help children learn skills like designing an opinion survey and choosing the appropriate measuring tool are not readily available for elementary school students. However, the USMES "How To" Series fills this gap. Its cartoon-style format helps younger children and those with reading difficulties acquire the skills and knowledge they need to do things like redesign their classroom, find the best buy in potato chips, or run a school store.

## How to Use the 'How To' Series

Wait for a need. When a student asks for help, refer him or her to the appropriate booklet. Having a child read a booklet before there is a need to do so will not only result in less effective learning but will defeat the USMES purpose of allowing children to decide what needs to be done.

When necessary, use the "How To" Series as a teaching aid. Most of the time children will be able to go through a booklet by themselves and learn the skills they need to learn. However, some material in some sets is difficult and somewhat abstract. Such sections are usually towards the ends of booklets and often labeled "extra." When the booklet by itself is not doing the job, feel free to step in and help the student go through it.

Knowing how the content of the booklets are organized may help in using the series effectively.

- Each cover page summarizes what is in the booklet by illustrating the general problem and solution.
- Each booklet contains several examples of children using the skill being taught. Each example emphasizes a different aspect of the skill or a potential pitfall.
- Where a skill covered in one booklet is used in another, there is a reference in the form: "See "How To...."

# OTHER USMES 'HOW TO' SERIES

Intermediate "How To" Series: This magazine-style series covers in more detail essentially the same material as the cartoon-style series with a few booklets on additional skills. This series gives students a chance to read something they have a need to read.

Design Lab "How To" Series: These illustrated cards help children learn how to use tools safely and effectively.

"How To" Cards: These cards are printed on colored card stock rather than paper as the other series are. They contain fewer words than the *Intermediate "How To" Series* and utilize the American system of units (ft.-lb.-sec.) rather than the metric system.

# BEGINNING "HOW TO" SERIES

## BIOLOGY

How To
- Make a Home for Your Animal
- Make a Home for Your Rodent

## COLLECTING DATA

How To
- Record Data
- Do an Experiment
- Make an Opinion Survey
- Choose a Sample

## ELECTRICITY

How To
- Make Simple Circuits
- Make a Circuit Stay Together
- Add Things to a Circuit
- Make and Use Switches
- Fix a Circuit

## GRAPHING

How To
- Choose Which Graph to Make
- Make a Bar Graph
- Make a Bar Graph Histogram
- Make a Conversion Graph
- Make a Line Chart
- Make a Line Graph
- Make a Scatter Graph
- Make a Slope Diagram

## MEASURING

How To
- Use a Stopwatch
- Choose the Right Tool to Measure Distance
- Use a Trundle Wheel
- Make a Scale Drawing
- Find the Speed of Things

## SIMPLIFYING DATA

How To
- Round Off Data
- Find the Median
- Find the Average

Conceived and Written by:
Sally Agro, Betty M. Beck, L. Ray Brady Jr., Edward Manfre

Illustrator
John M. Evans

Art Director
John W. Saalfield

Production Assistance
Paula Lakeberg

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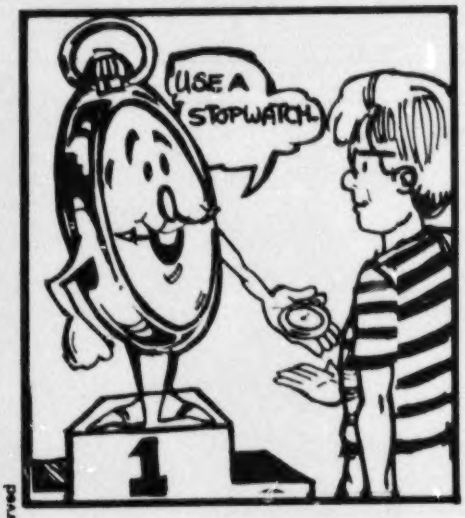
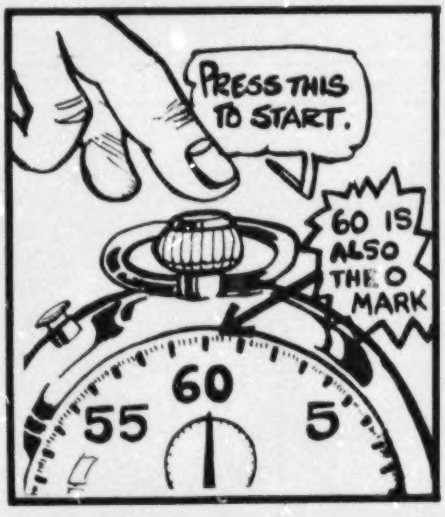
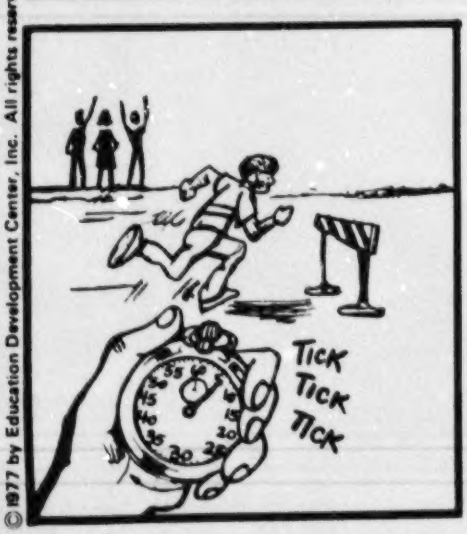
# HOW TO
# USE A STOPWATCH





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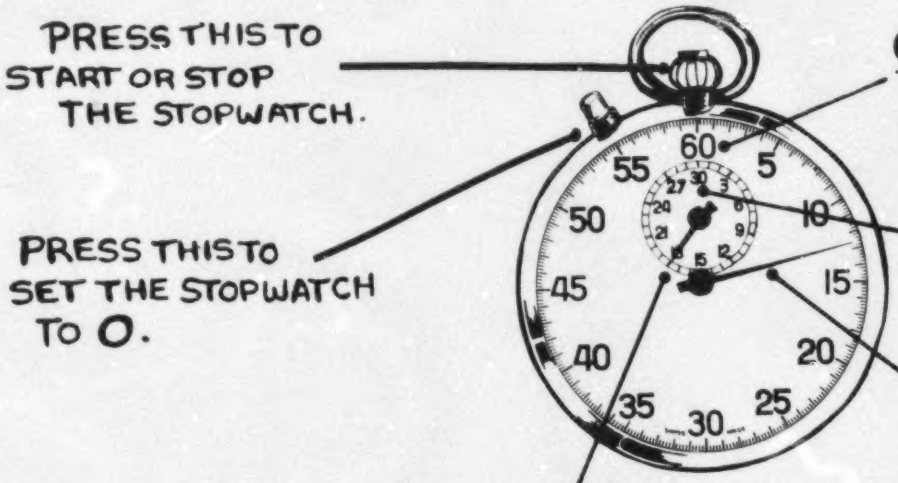
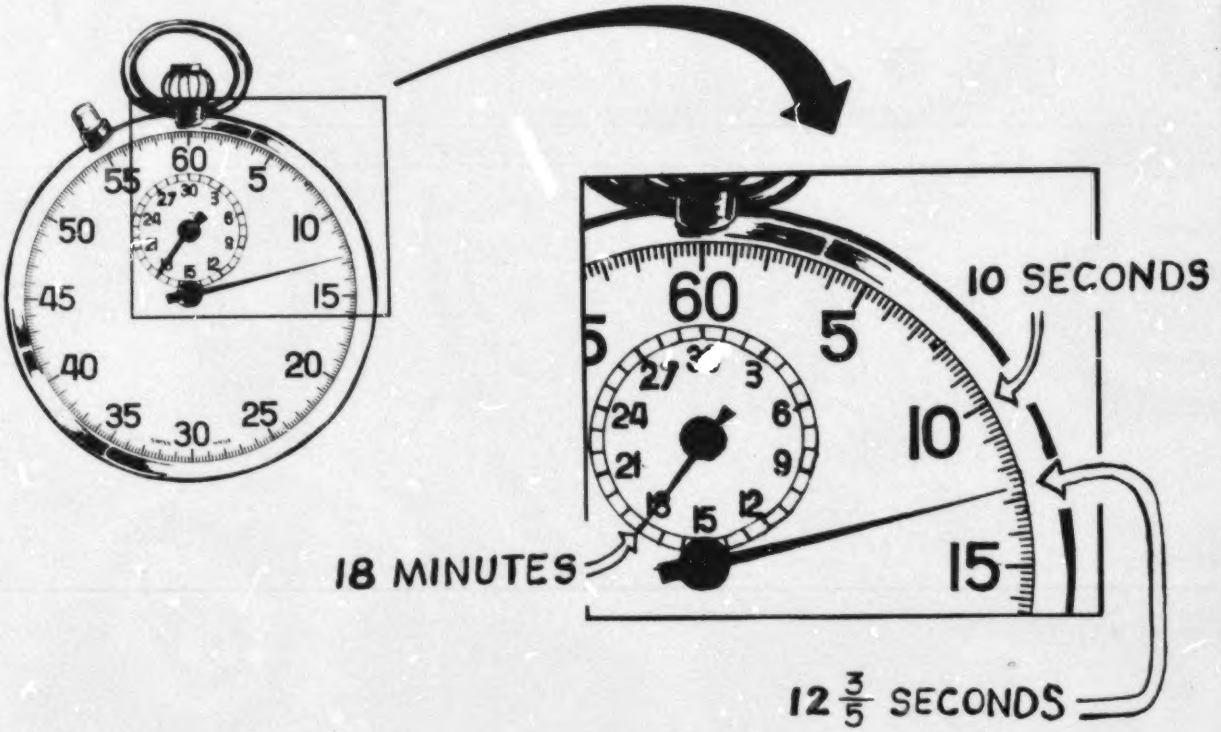
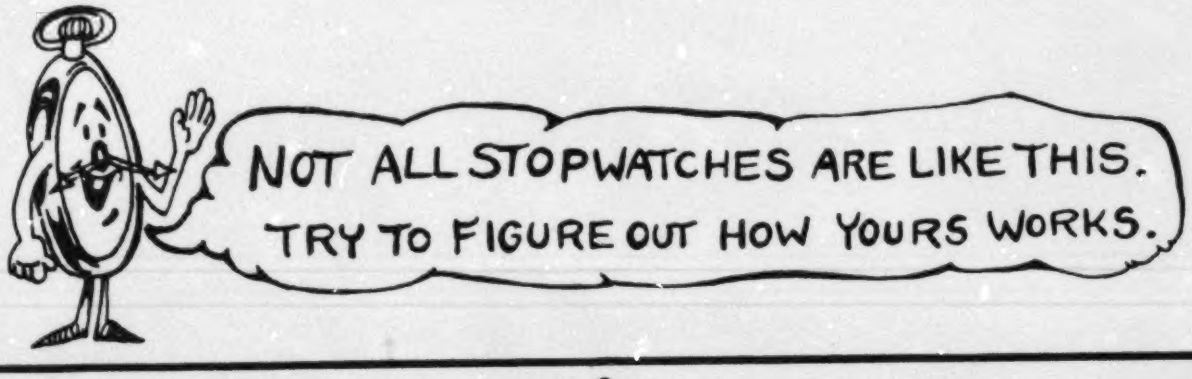
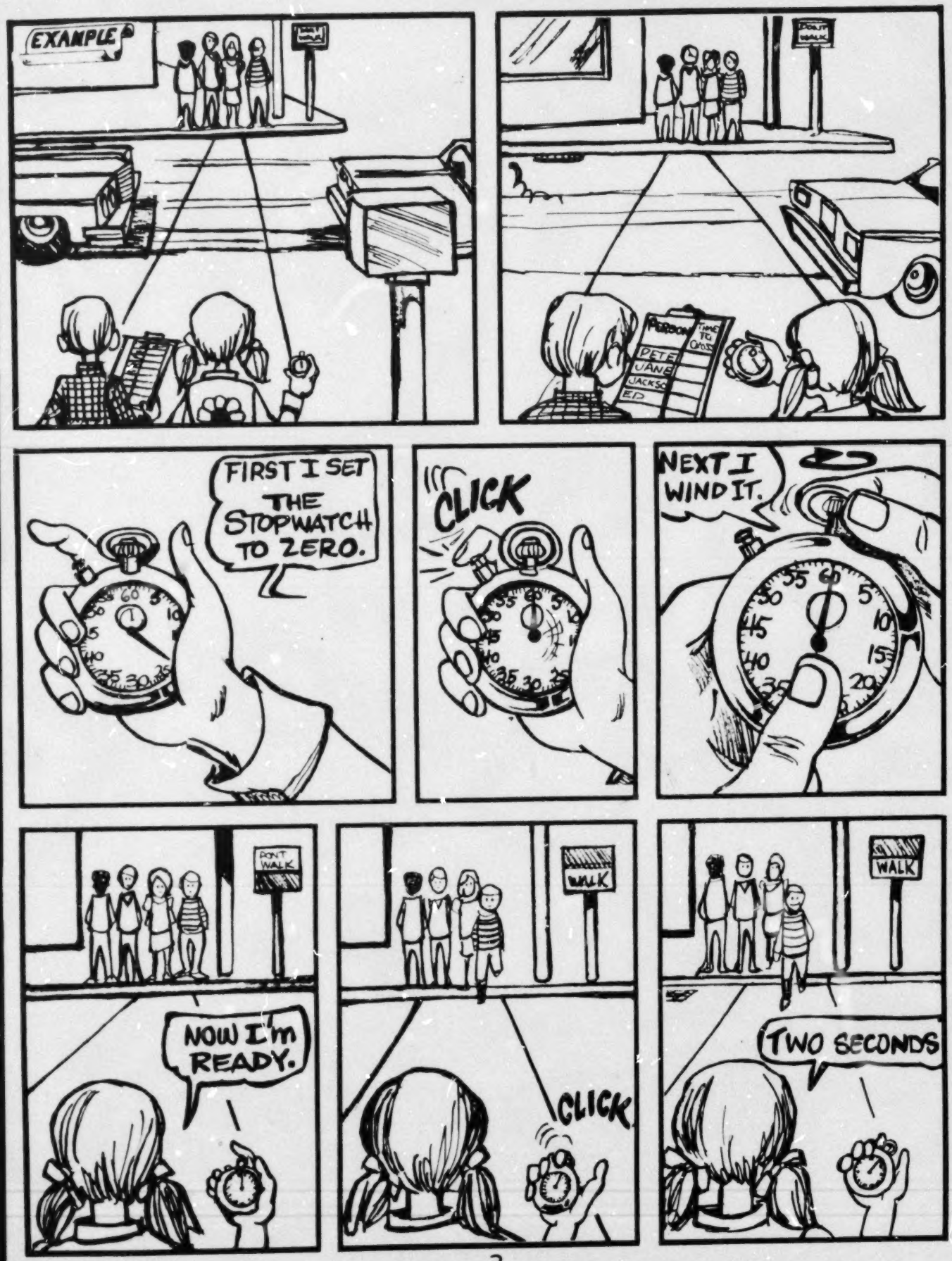

PRESS THIS TO START OR STOP THE STOPWATCH.
PRESS THIS TO SET THE STOPWATCH TO 0.
60 IS ALSO THE 0 MARK FOR SECONDS
30 IS ALSO 0 MINUTES
SECOND HAND
MINUTE HAND

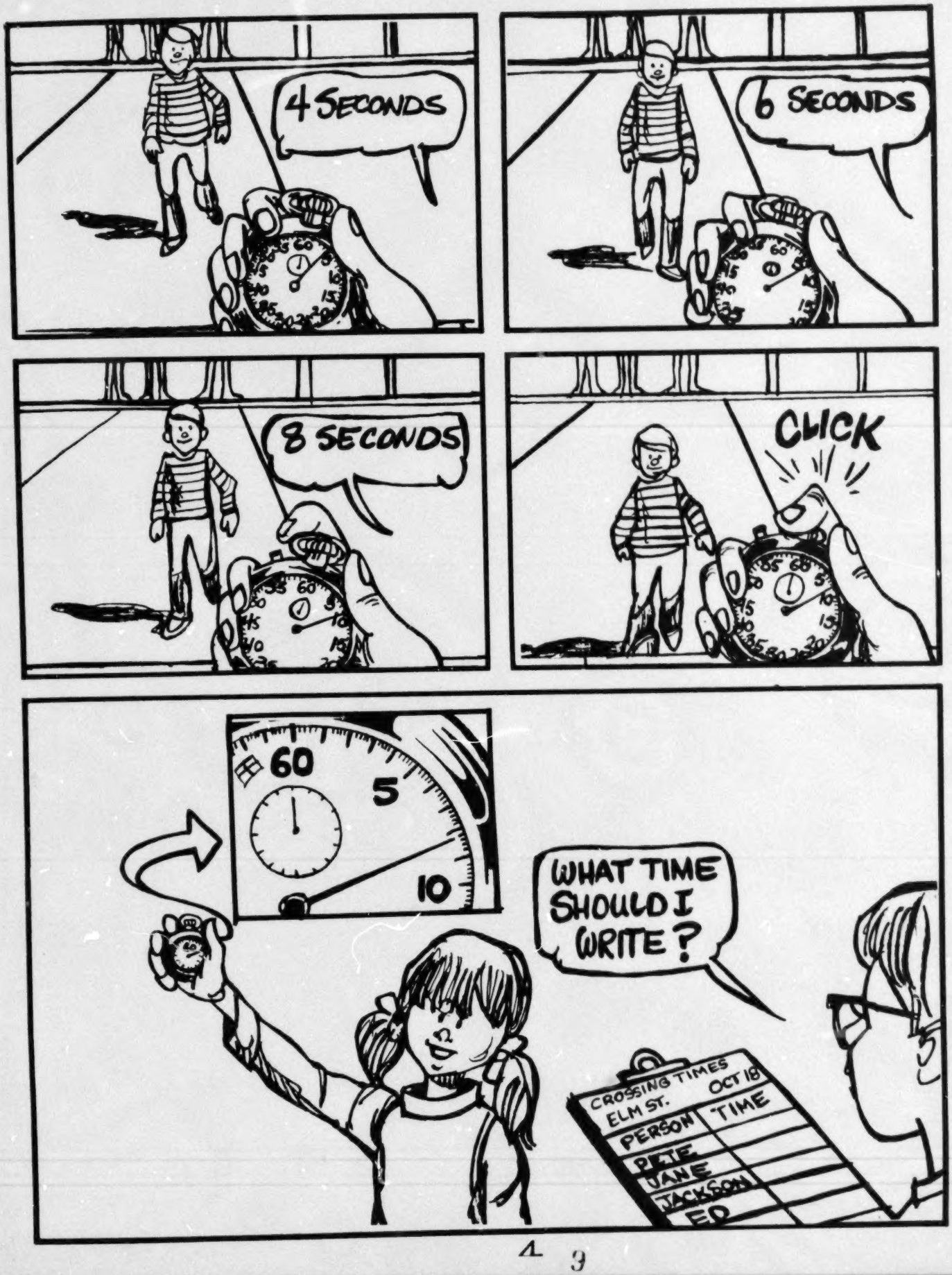

10 SECONDS
18 MINUTES
12 3/5 SECONDS


NOT ALL STOPWATCHES ARE LIKE THIS.
TRY TO FIGURE OUT HOW YOURS WORKS.


EXAMPLE
DON'T WALK
PERSON
TIME TO CROSS
PETE
JANE
JACKSON
ED
FIRST I SET THE STOPWATCH TO ZERO.
CLICK
NEXT I WIND IT.
DON'T WALK
NOW I'm READY.
WALK
CLICK
WALK
TWO SECONDS



3


4 SECONDS
6 SECONDS
8 SECONDS
CLICK
60
5
10
WHAT TIME SHOULD I WRITE?
CROSSING TIMES
ELM ST. OCT 18
PERSON
TIME
PETE
JANE
JACKSON
ED

LOOK CLOSELY.
8 SECONDS...
5
10
... PLUS ONE-FIFTH OF A SECOND...
10
...IS 8⅕ SECONDS.
OR YOU CAN ROUND OFF TO 8 SECONDS.
SEE HOW TO ROUND OFF DATA.
WALK
CROSSING TIMES
ELM ST.
QTR.
PERSON
TIME
PETE
8 SEC.
JANE
JACKSON
ED

EXAMPLE
BRRRRING
BRRRRING
FIRE DRILL!
BRRRRING
WE CAN FIND OUT NEXT TIME.
HOW FAST DID WE GET OUT?
LATER
BRRRRRING
FIRE DRILL
CLICK
BRRRING
EXIT
TICK
TICK
TICK
THAT'S IT.
CLICK
2 MINUTES
AND 7 SECONDS
FIRE DRILL SERIES
EXIT TIME
2:07

EXAMPLE
TICK
TICK
TICK
TIME OUT.
CLICK
CLICK
TICK TICK
TEAM
HAWKS
TEAM
NICKS
YEA! WE WON!
10 MINUTES TIME'S UP.
CLICK

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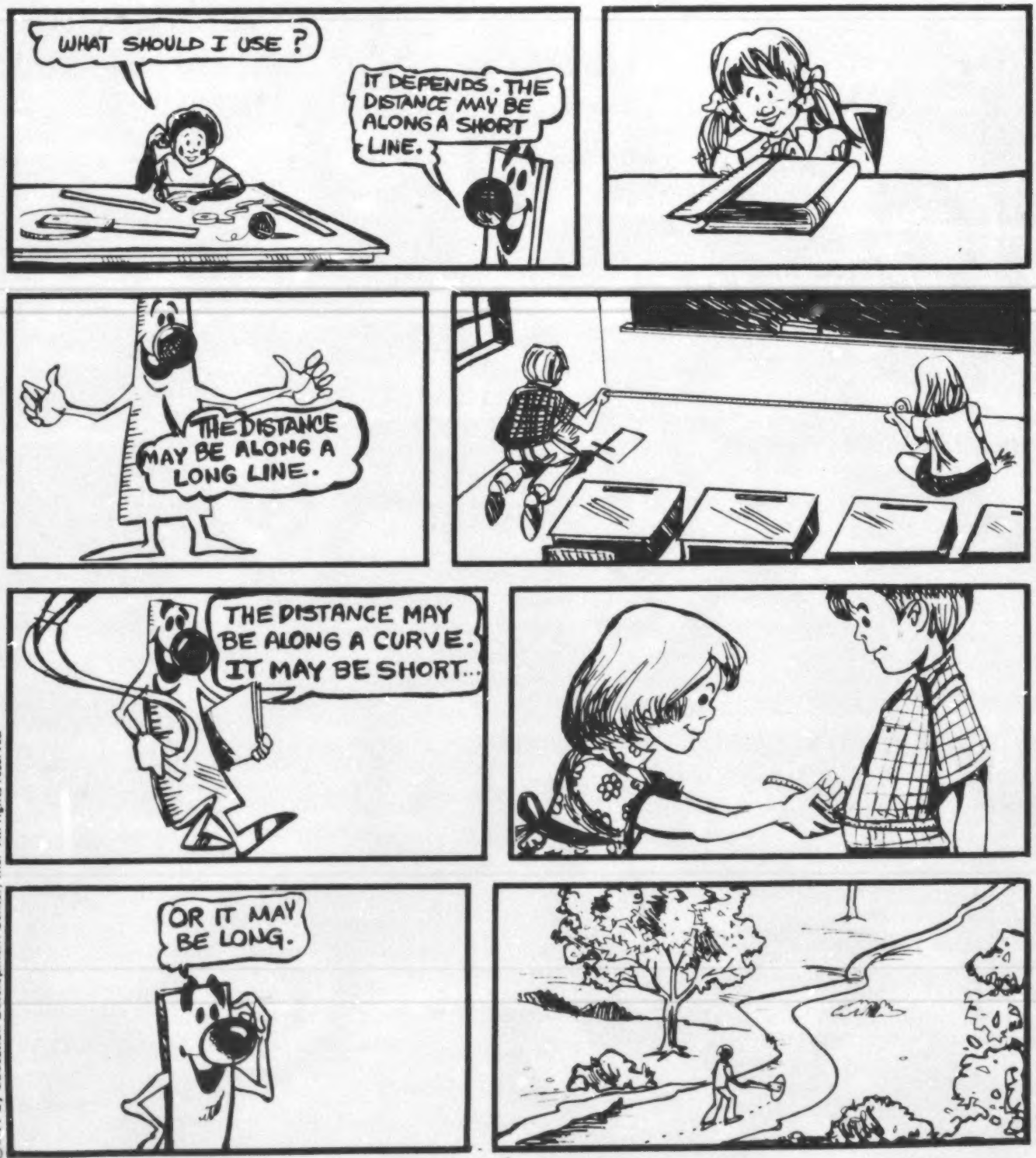
ISBN 0 89292 029 7

HOW TO

# CHOOSE THE RIGHT TOOL TO MEASURE DISTANCE


WHAT SHOULD I USE?
IT DEPENDS. THE DISTANCE MAY BE ALONG A SHORT LINE.
THE DISTANCE MAY BE ALONG A LONG LINE.
THE DISTANCE MAY BE ALONG A CURVE. IT MAY BE SHORT...
OR IT MAY BE LONG.

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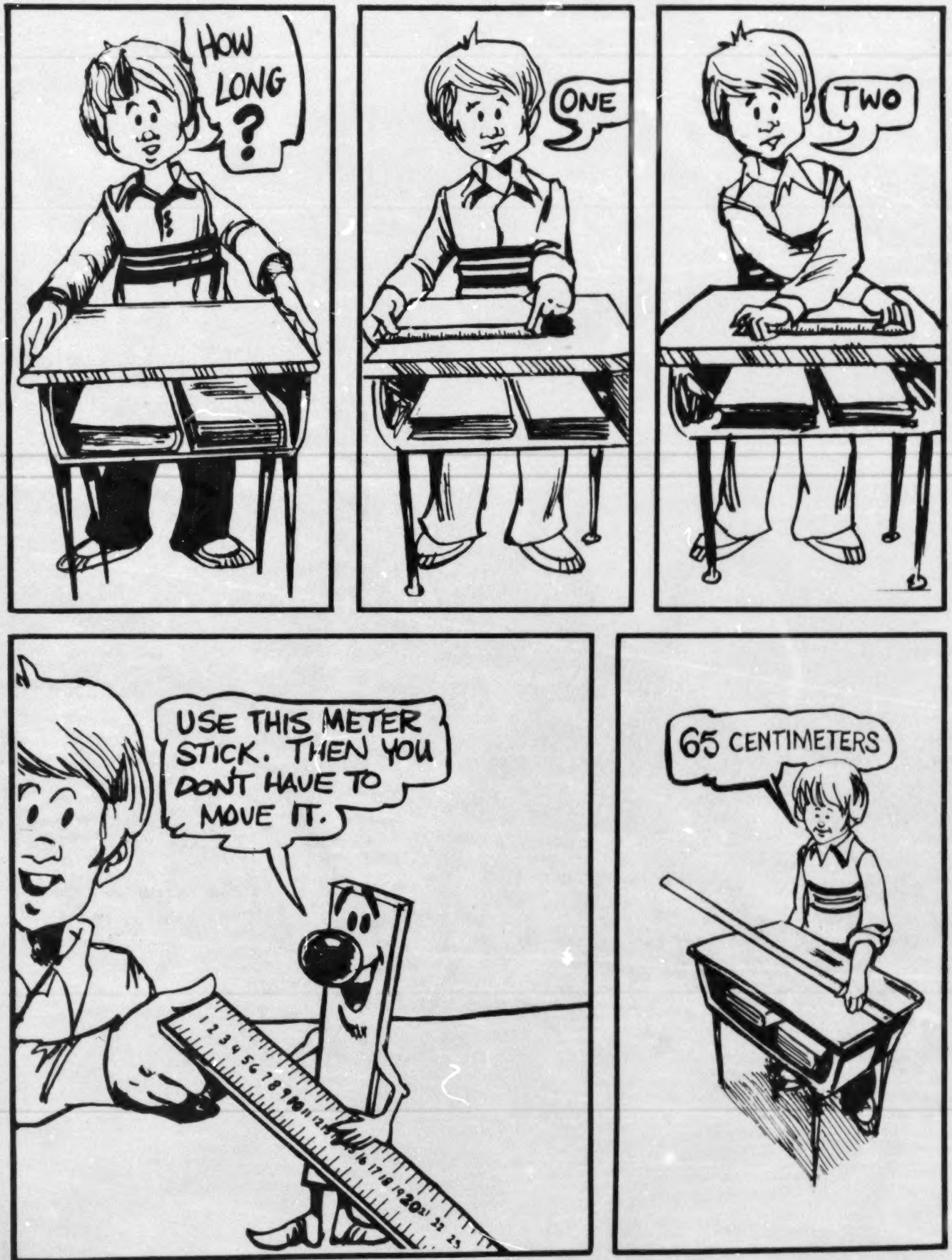
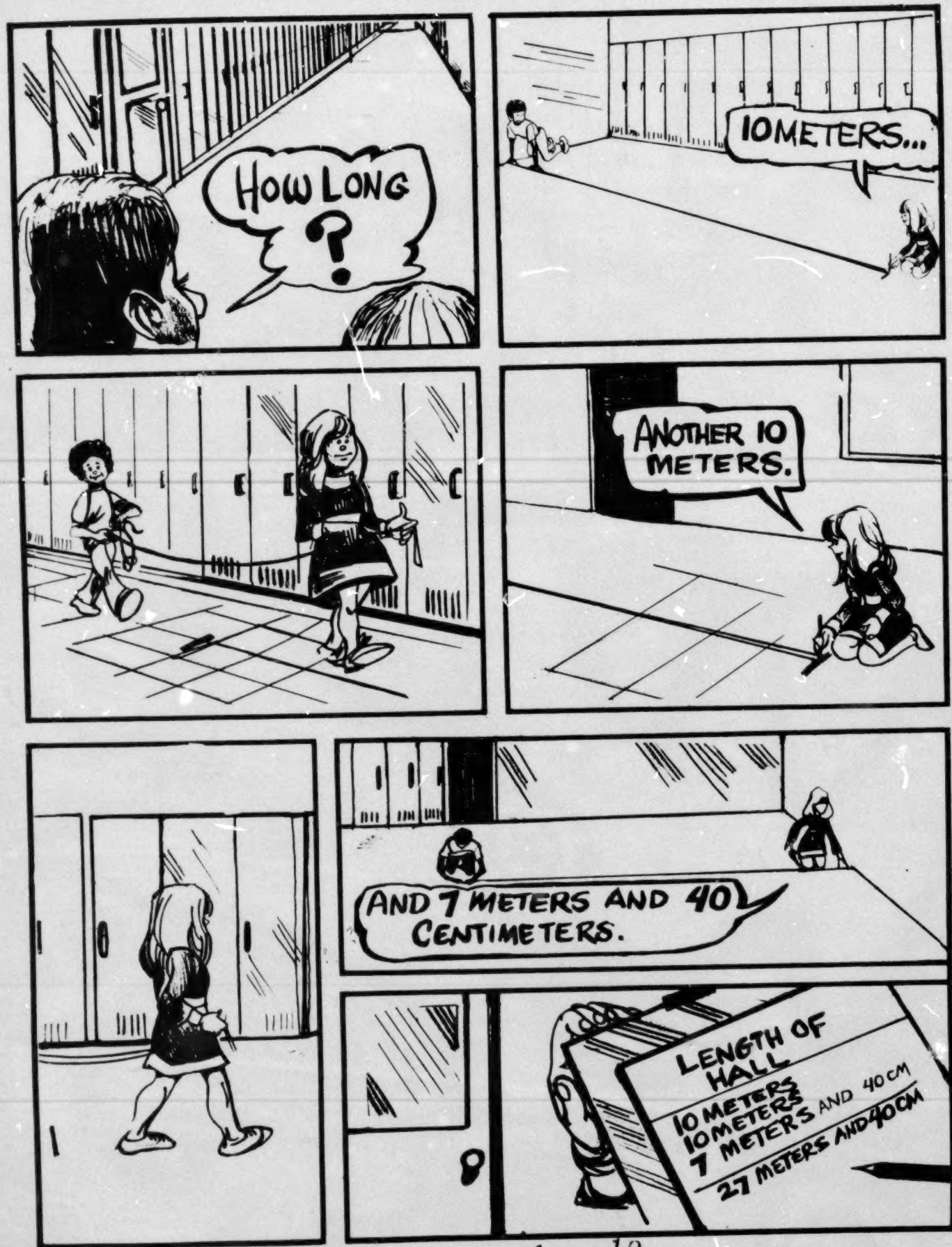
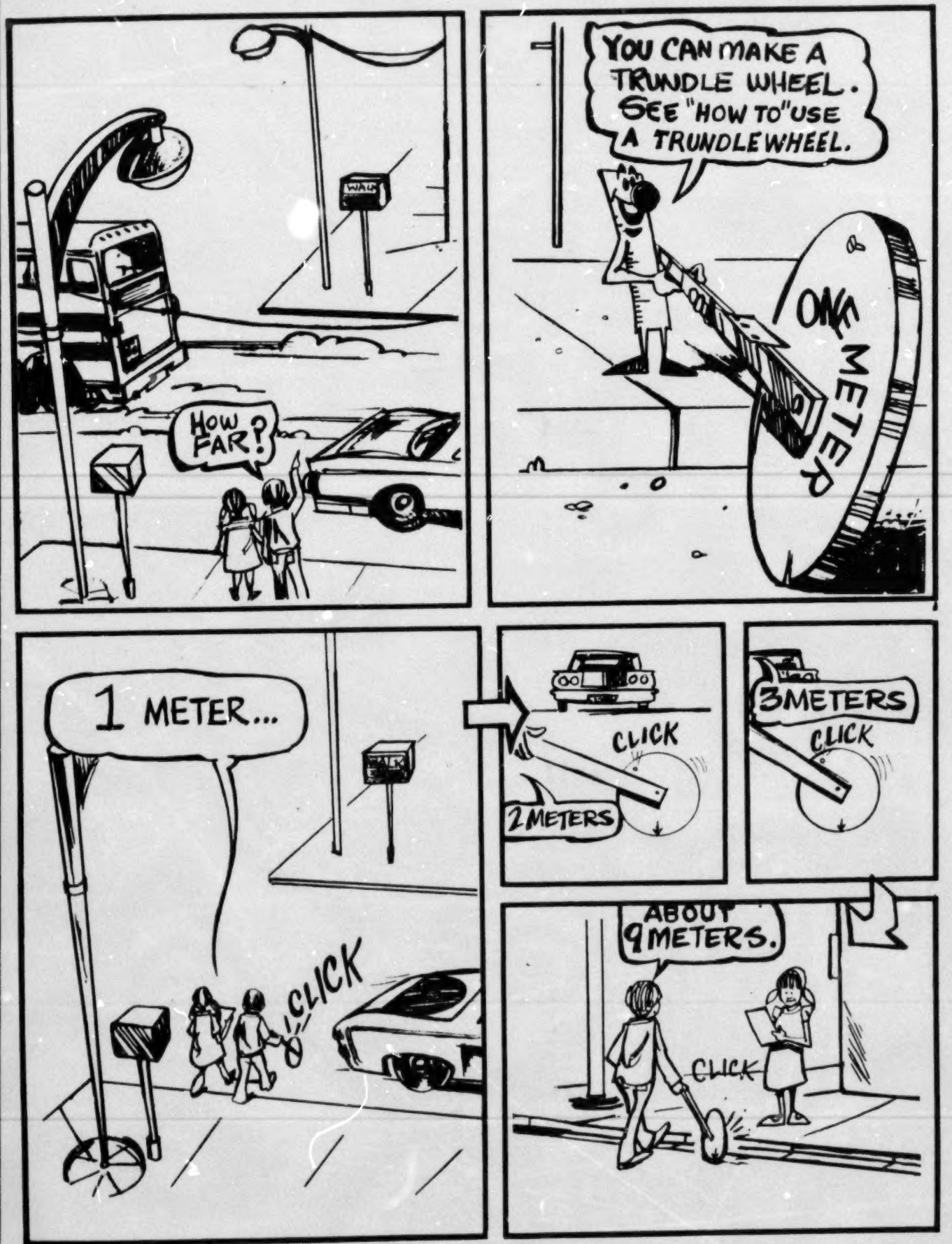
HOW LONG.
?
HOW WIDE?
HOW WIDE ?
TRY MAKING YOUR OWN TOOLS.


HOW LONG ?
ONE
TWO
USE THIS METER STICK. THEN YOU DONT HAVE TO MOVE IT.
65 CENTIMETERS

1 METER...
OOPS! IT SLIPPED.
1 METER AND 90 CENTIMETERS

THE HALLWAY IS TOO NOISY.
WE WANT TO BUY A CARPET.
HOW LONG ?
LET'S MEASURE WITH OUR FEET.
1
75,76...
...152,153.
HALL
153 OF JOE'S FEET
LET ME TRY.
178,179.
IT'S 179.
NO, IT'S 153
179 OF SUE'S FEET
OR
153 OF JOE'S FEET
THE MEASUREMENTS ARE DIFFERENT.
BUT JOE'S SHOE IS LONGER.
WHICH NUMBER SHOULD WE USE?
USE A TAPE MEASURE, IT'S BETTER.


HOW LONG ?
10METERS...
ANOTHER 10 METERS.
AND 7 METERS AND 40 CENTIMETERS.
LENGTH OF HALL
10 METERS
10METERS
7 METERS AND 40 CM
27 METERS AND40CM


WALK
HOW FAR?
YOU CAN MAKE A TRUNDLE WHEEL. SEE "HOW TO" USE A TRUNDLE WHEEL.
ONE METER
1 METER...
CLICK
CLICK
2 METERS
3 METERS
CLICK
ABOUT 9 METERS.
CLICK

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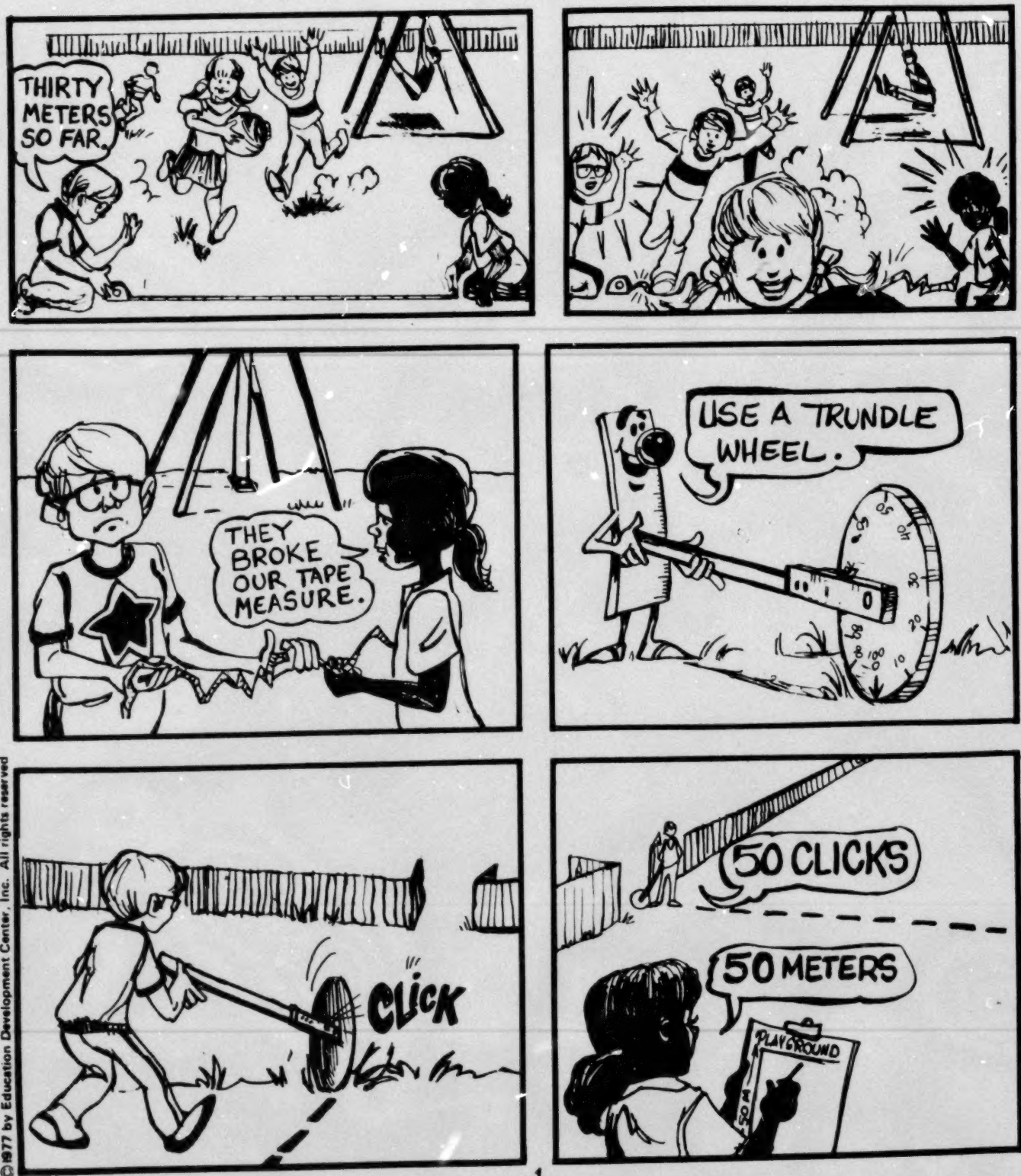
# HOW TO
# USE A TRUNDLE WHEEL

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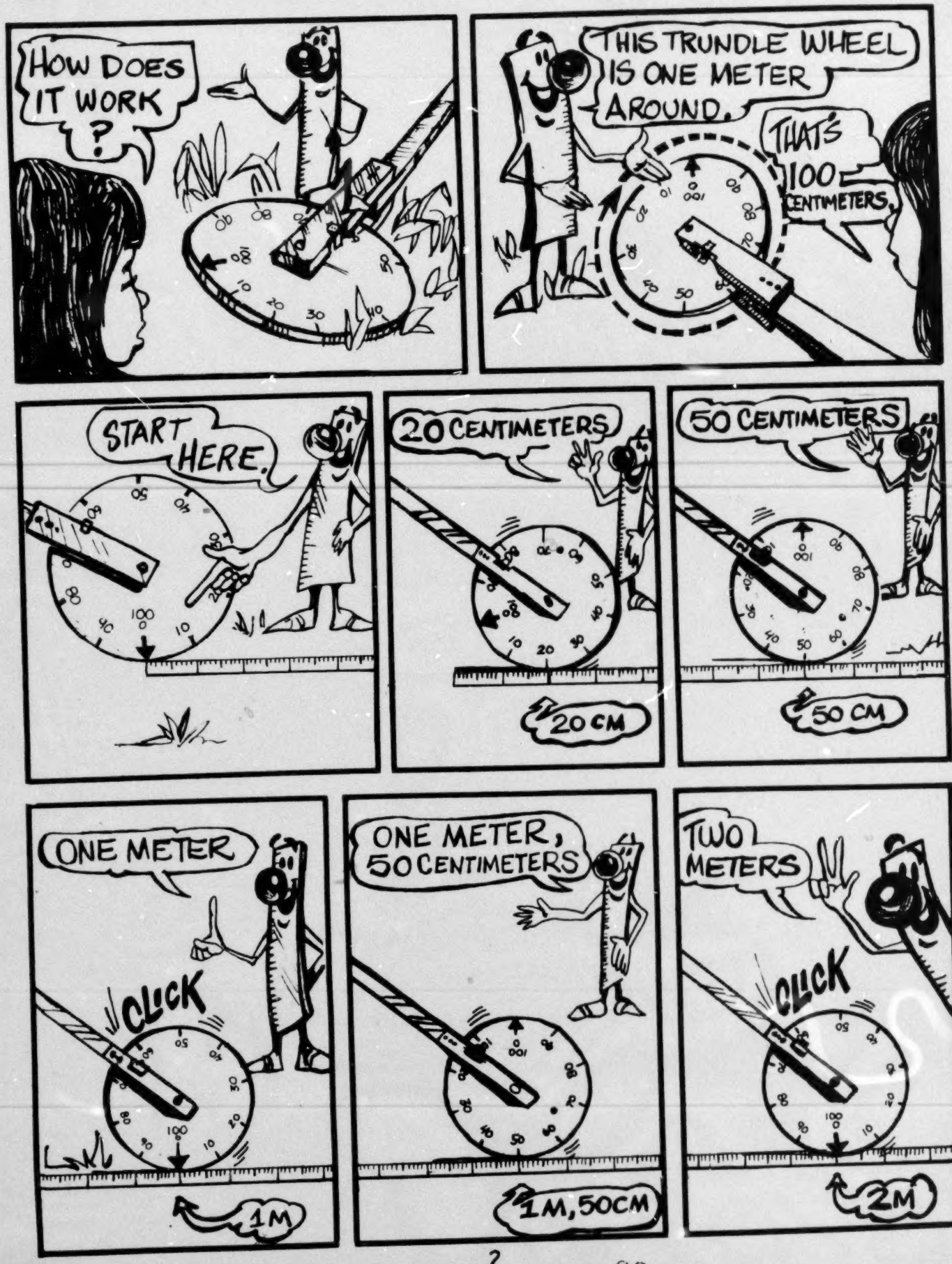
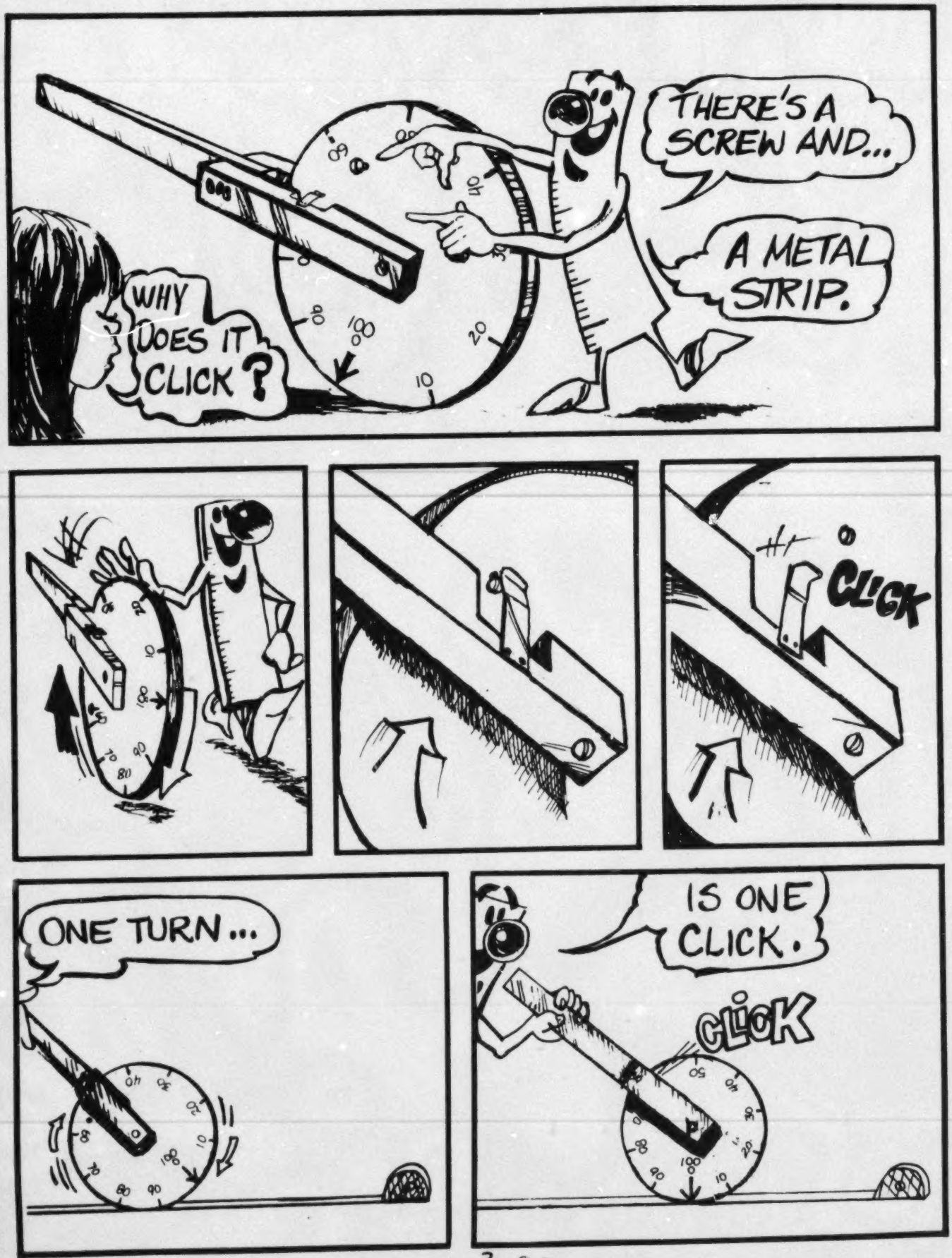
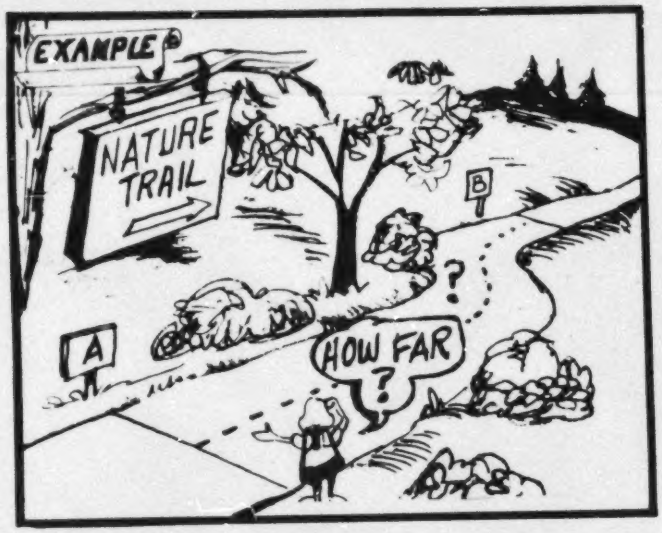
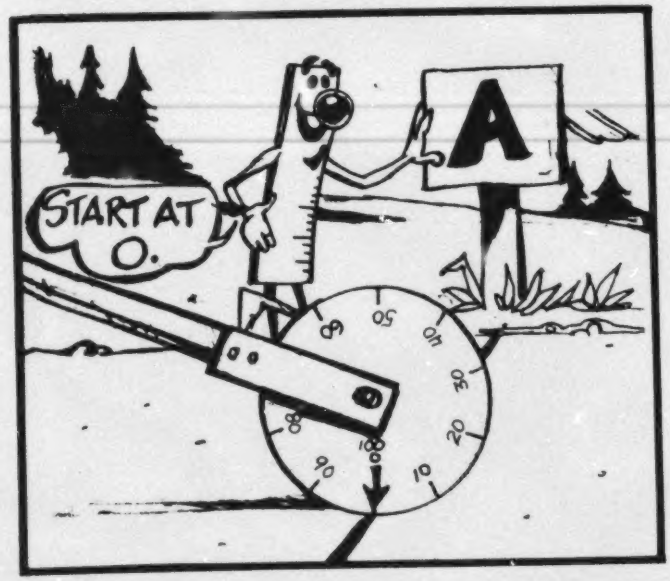
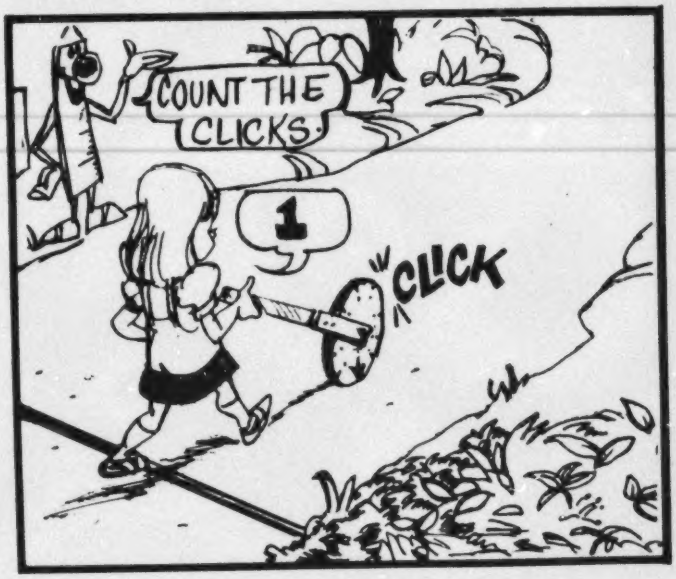

HOW DOES IT WORK ?
THIS TRUNDLE WHEEL IS ONE METER AROUND.
THAT'S 100 CENTIMETERS.
START HERE.
20 CENTIMETERS
20 CM
50 CENTIMETERS
50 CM
ONE METER
CLICK
1M
ONE METER, 50 CENTIMETERS
1M, 50CM
TWO METERS
CLICK
2M

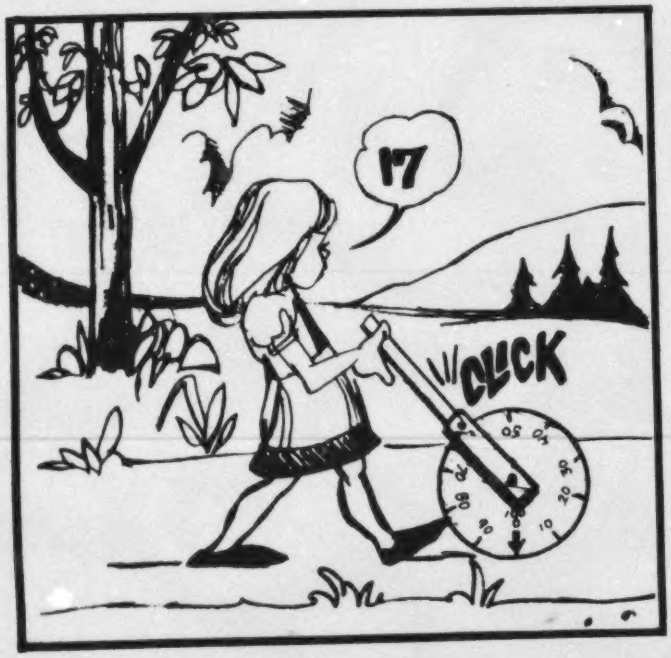

WHY DOES IT CLICK?
THERE'S A SCREW AND...
A METAL STRIP.
CLICK
ONE TURN...
IS ONE CLICK.
CLICK

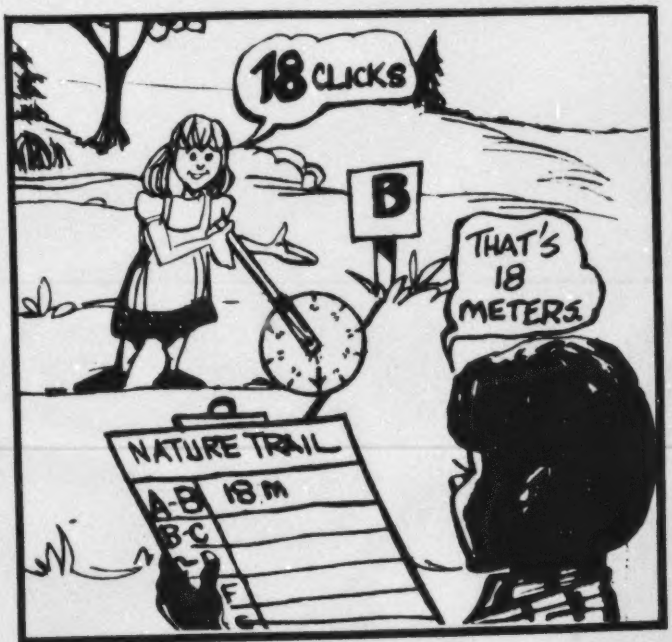

EXAMPLE
NATURE TRAIL
A
B
?
HOW FAR ?

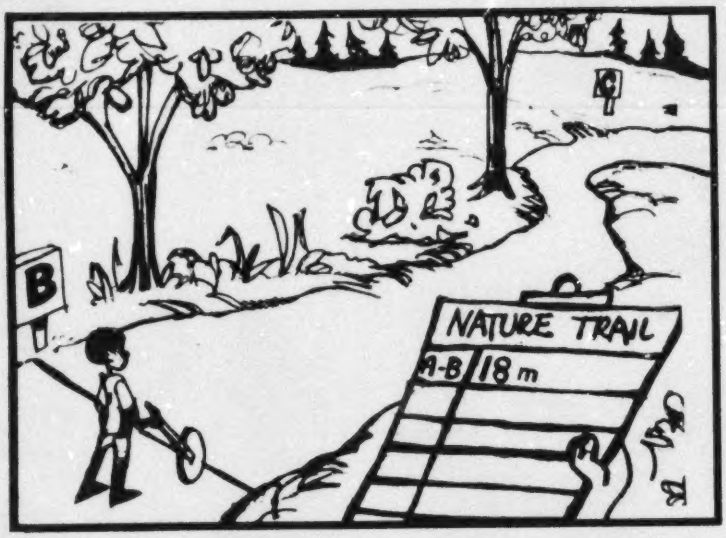
USE A TRUNDLE WHEEL

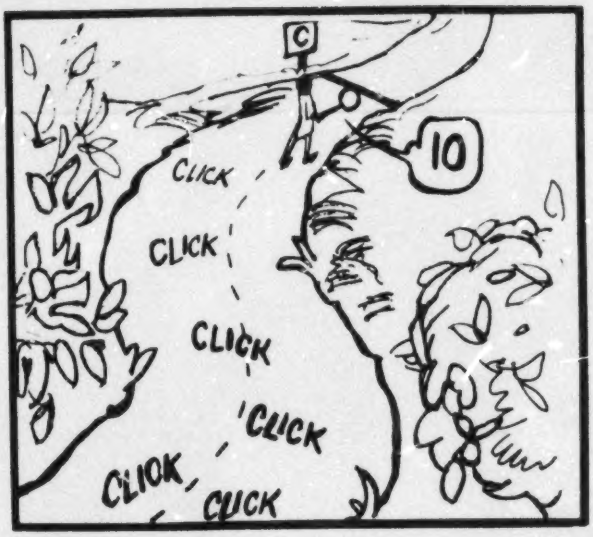

A
START AT 0.


COUNT THE CLICKS.
1
CLICK

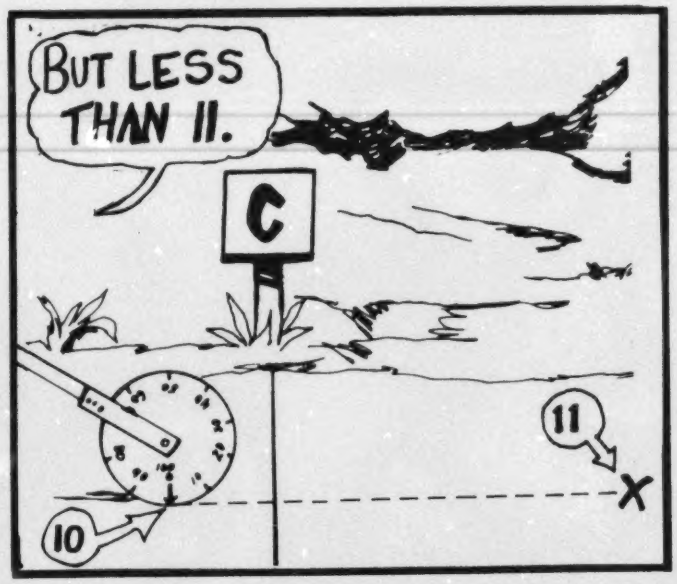

17
CLICK

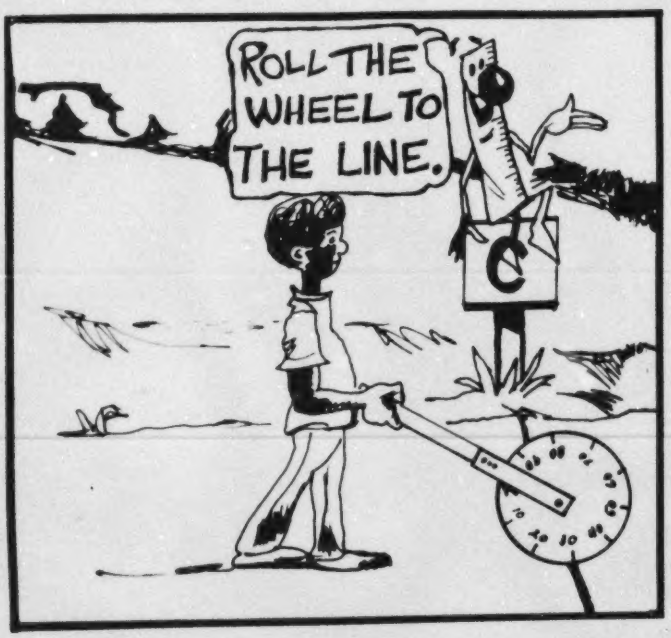

18 CLICKS
B
THAT'S 18 METERS.
NATURE TRAIL
A-B 18 m
B-C
F

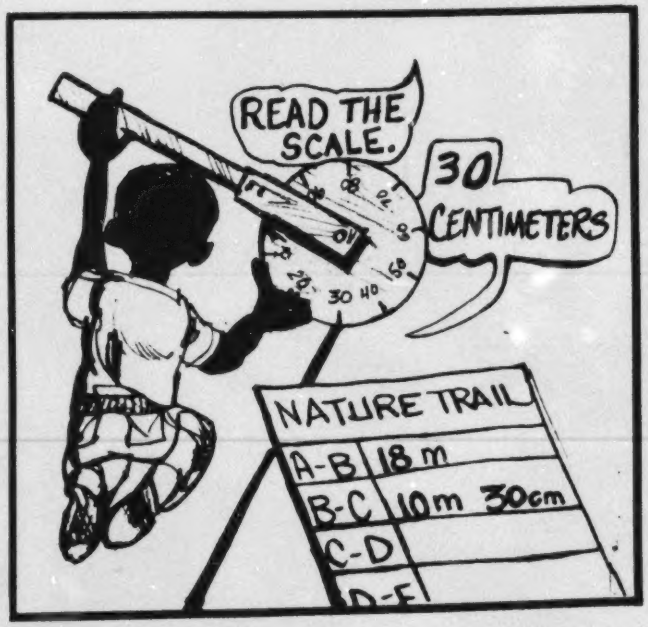

B
C
NATURE TRAIL
A-B 18 m


C
10
CLICK
CLICK
CLICK
CLICK
CLICK
CLICK

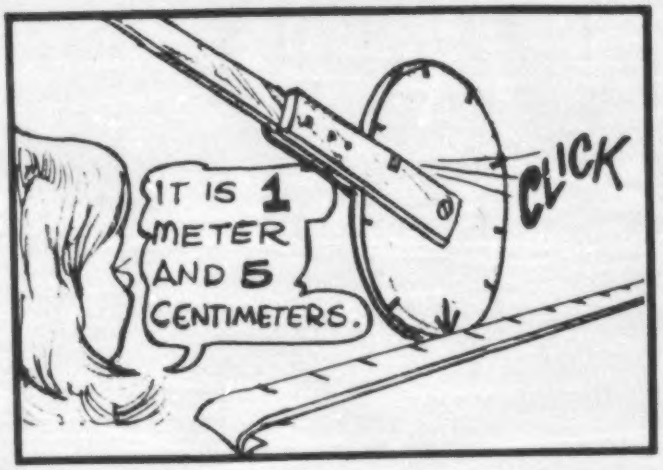
IT IS MORE THAN 10...
C


BUT LESS THAN 11.
C
11
10
X


ROLL THE WHEEL TO THE LINE.
C

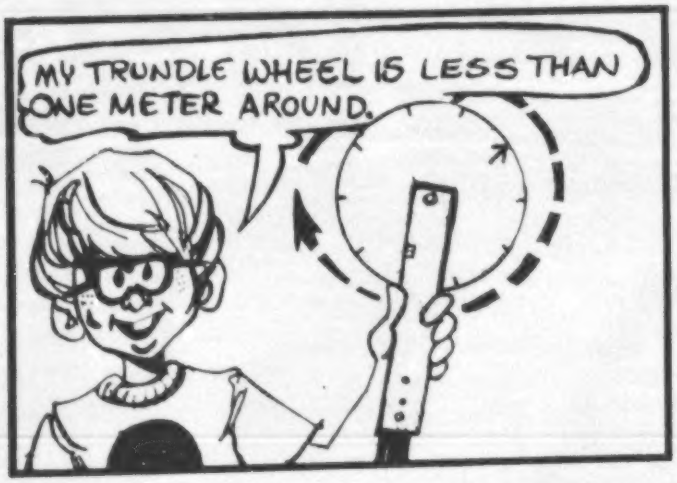

READ THE SCALE.
30 CENTIMETERS
NATURE TRAIL
A-B 18 m
B-C 10m 30cm
C-D
D-E

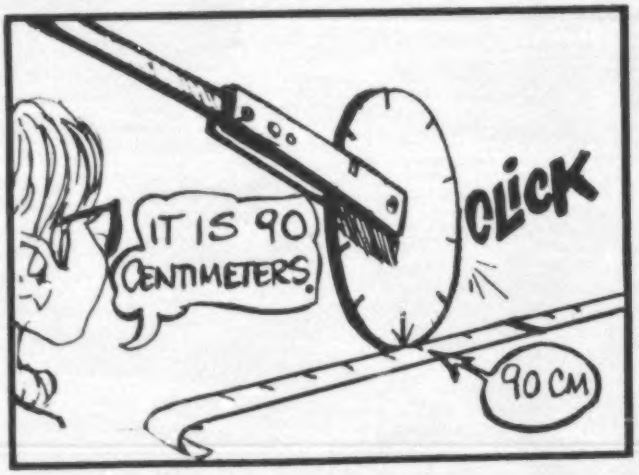
EXAMPLE
GYM
CLICK
IT'S 20 METERS TO HERE...
BUT, THE BOTTOM OF THE WHEEL WON'T REACH THE WALL.
USE A RULER.
IT'S ABOUT 16 CENTIMETERS.
THE GYM IS ABOUT 20 METERS 16 CENTIMETERS WIDE.
GYM
20m
16Cm




**1 CLICK** ⇨ 1 TURN × (1 METER AND 5 CENTIMETERS) = 1 METER AND 5 CENTIMETERS

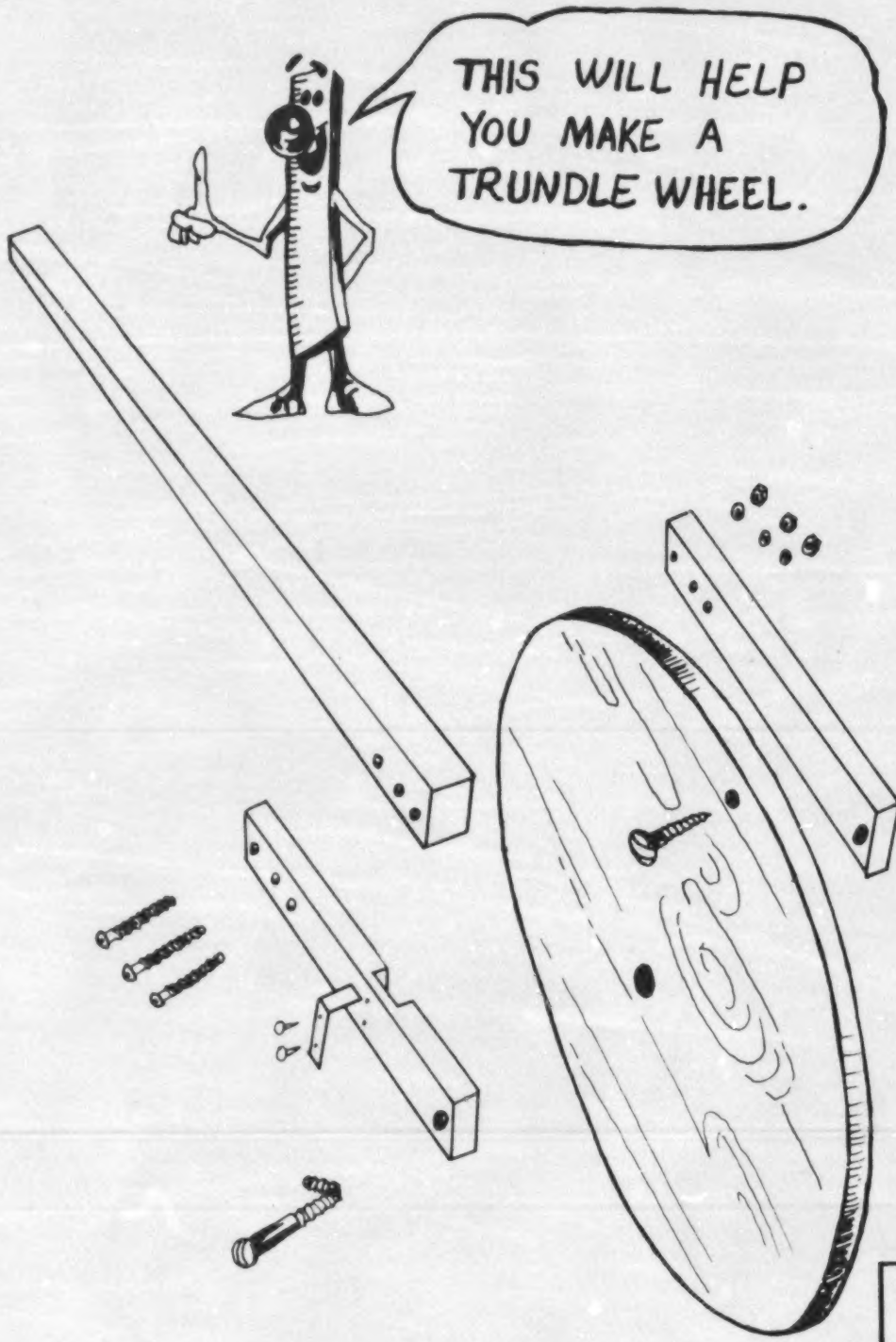
**10 CLICKS** ⇨ 10 TURNS × (1 METER AND 5 CENTIMETERS) = 10 METERS AND 50 CENTIMETERS

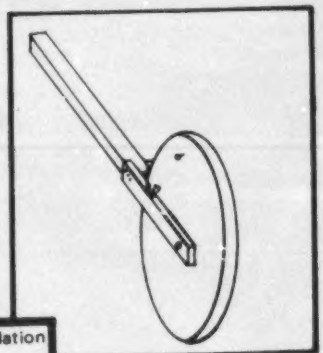



**1 CLICK** ⇨ 1 TURN × 90 CENTIMETERS = 90 CENTIMETERS

**10 CLICKS** ⇨ 10 TURNS × 90 CENTIMETERS = 900 CENTIMETERS OR 9 METERS



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A

HOW TO

# MAKE A SCALE DRAWING

MY DRAWING LOOKS WRONG.
YOU MADE THE DOOR TOO BIG.
YOU NEED TO MAKE A SCALE DRAWING.
FIRST MEASURE THE THINGS THAT YOU WANT IN YOUR DRAWING.
NEXT DECIDE ON A SCALE. 1 METER IN THE ROOM CAN BE 1 SPACE ON THIS GRAPH PAPER.
NOW THE DRAWING LOOKS RIGHT.
OUR CLASSROOM
DOOR
WINDOW
SCALE: 1 SPACE ↔ 1 METER

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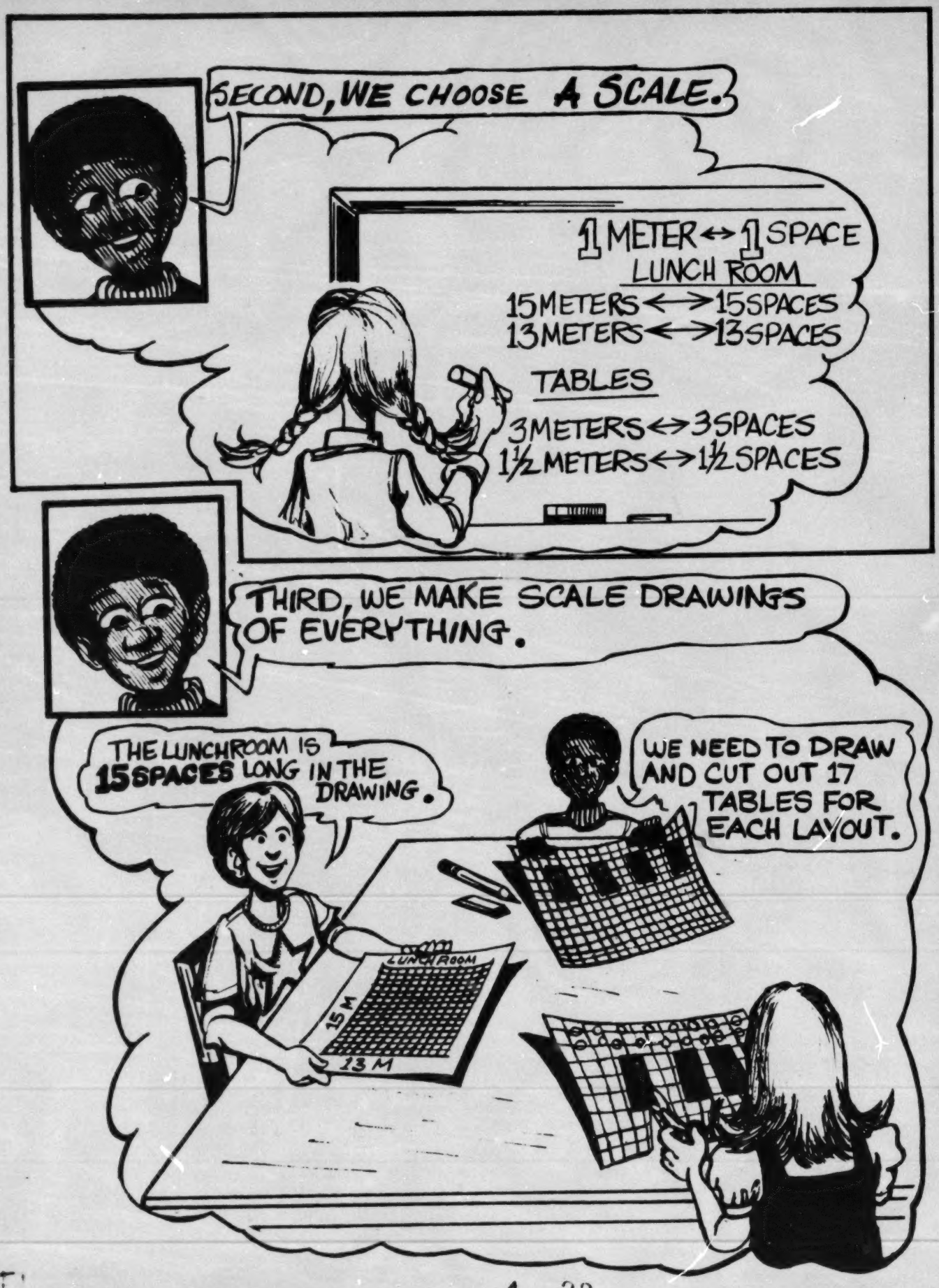
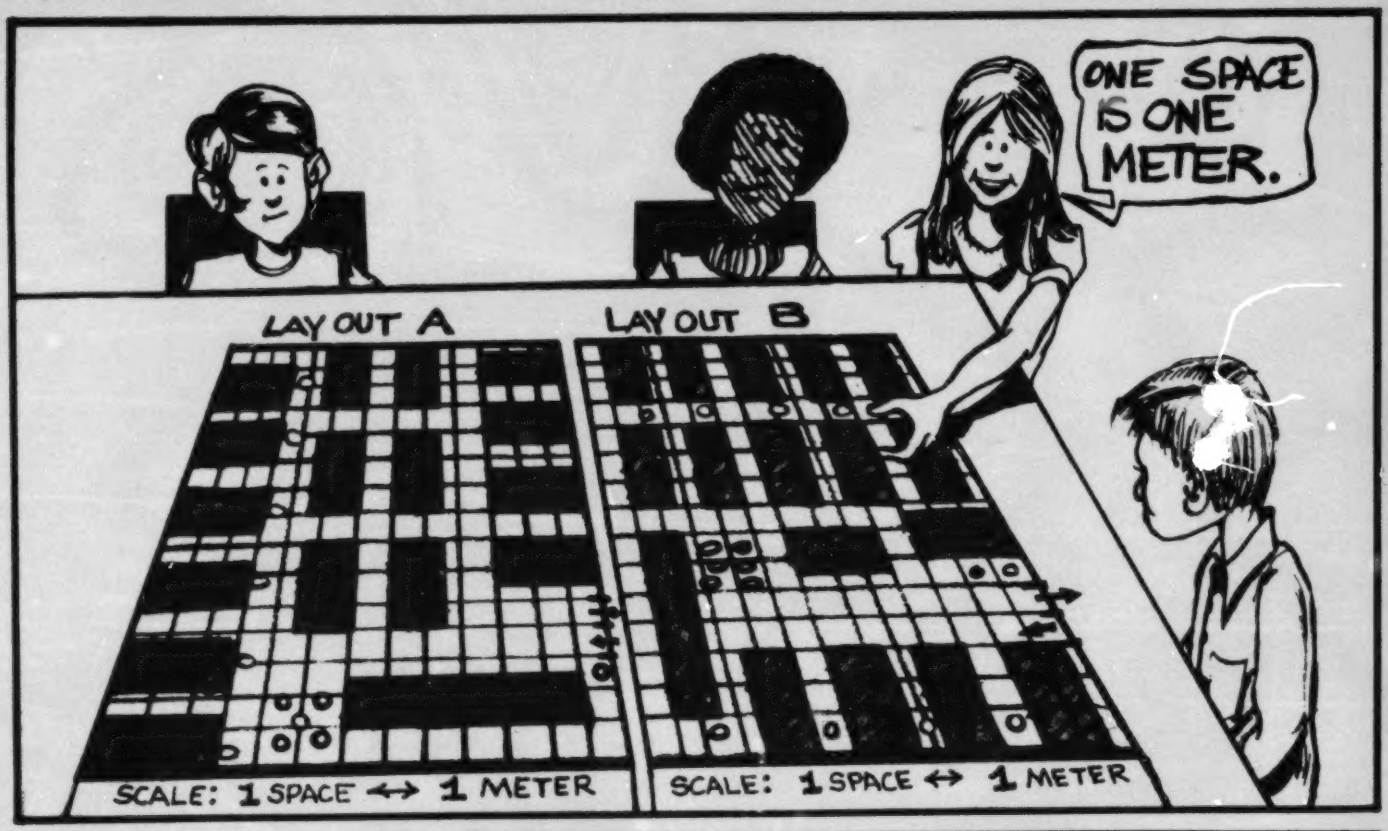
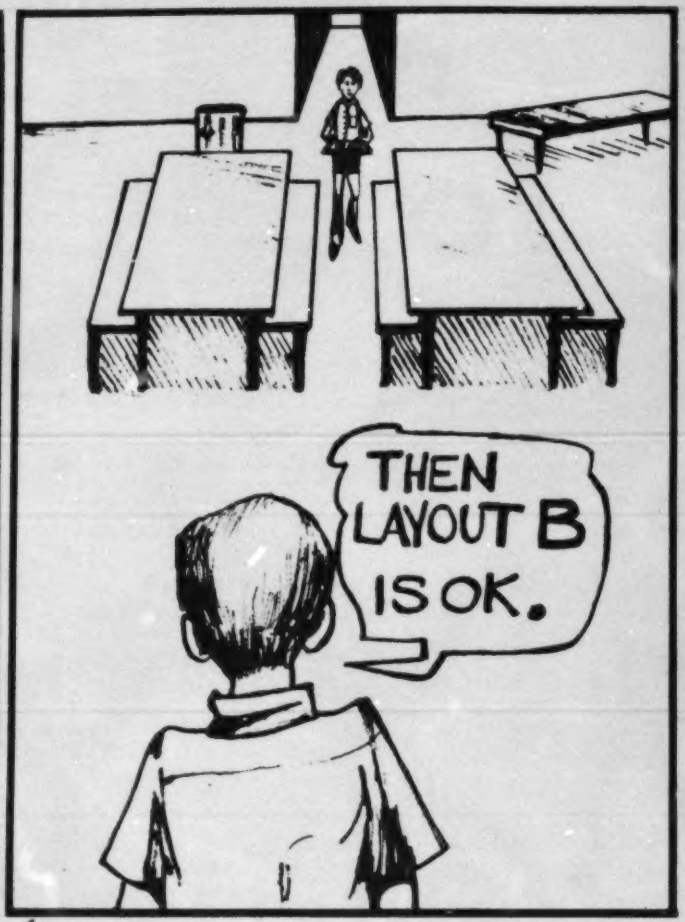
I STARTED TO MAKE A SCALE DRAWING OF THE PLAYGROUND BUT MY DRAWING WILL BE TOO BIG FOR THE PAPER.
WHAT SCALE DID YOU USE?
50m
25m
I USED 1 SPACE FOR EVERY METER.
YOU CAN'T DO THAT! OUR GRAPH PAPER ISN'T 100 SPACES LONG.
LET 1 SPACE STAND FOR MORE THAN 1 METER THEN YOUR SCALE DRAWING WILL BE SMALLER.
METER STICK
METER STICK
METER STICK
IF I LET 1 SPACE STAND FOR 10 METERS, MY SCALE DRAWING WILL BE 10 SPACES LONG.
THAT'S TOO SMALL. TRY 1 SPACE FOR EVERY 5 METERS.
I USED 1 SPACE FOR 5 METERS. NOW THE SCALE DRAWING FITS THE PAPER.
50 METERS
SCALE: 1 SPACE ↔ 5 METERS

THE LUNCHROOM NEEDS ANOTHER TABLE
WHERE DO WE PUT IT?
WE NEED A PLAN.
LION
YOU CAN MAKE SCALE LAYOUTS TO TRY DIFFERENT PLANS.
FIRST WE MEASURE THE LUNCHROOM AND EVERYTHING IN IT.
THE LUNCH ROOM IS 15 METERS LONG AND 13 METERS WIDE.
THE TABLE IS 3 METERS LONG AND 1 1/2 METERS WIDE.
THE TRASH CAN IS 1/2 METER IN DIAMETER.


SECOND, WE CHOOSE A SCALE.
1 METER ↔ 1 SPACE
LUNCH ROOM
15 METERS ↔ 15 SPACES
13 METERS ↔ 13 SPACES
TABLES
3 METERS ↔ 3 SPACES
1½ METERS ↔ 1½ SPACES
THIRD, WE MAKE SCALE DRAWINGS OF EVERYTHING.
THE LUNCHROOM IS 15 SPACES LONG IN THE DRAWING.
WE NEED TO DRAW AND CUT OUT 17 TABLES FOR EACH LAYOUT.
LUNCH ROOM
15 M
13 M

FOURTH, WE TRY DIFFERENT LAYOUTS.
LUNCHROOM
15 M
13 M
LUNCHROOM
15 M
13 M
WHICH LAYOUT IS BETTER?
I LIKE LAYOUT B.
ME TOO!
IS THERE ENOUGH ROOM BETWEEN THE TABLES IN LAYOUT B?
LAYOUT A
LAYOUT B
SCALE: 1 SPACE ↔ 1 METER
SCALE: 1 SPACE ↔ 1 METER


ONE SPACE IS ONE METER.
LAY OUT A
LAY OUT B
SCALE: 1 SPACE ↔ 1 METER
SCALE: 1 SPACE ↔ 1 METER


THEN LAYOUT B IS OK.

EXIT
I WANT TO MAKE A BIG SCALE DRAWING OF THE DESIGN LAB.
DESIGN LAB
10 METERS WIDE
12 METERS LONG
WE DONT HAVE ANY GRAPH PAPER.
HOW TO CARDS
GRAPH PAPER
YOU CAN USE PLAIN PAPER. HOW BIG IS YOUR PAPER?
100 CENTIMETERS...
...BY 100 CENTIMETERS

EXTRA
CHOOSE A SCALE SO THAT YOUR DRAWING WILL ALMOST FILL UP THE PAPER.
DESIGN LAB
10 METERS WIDE
12 METERS LONG
HOW?
DIVIDE THE LENGTH OF THE PAPER BY YOUR LARGEST MEASUREMENT.
100 CENTIMETERS
12 METERS
THAT'S A LITTLE OVER 8 CENTIMETERS FOR 1 METER.
I CAN LET 1 METER BE 8 CENTIMETERS. THEN THE DRAWING WILL ALMOST FILL UP THE PAPER.
1M ↔ 8 cm
12M ↔ 96 cm
10M ↔ 80 cm
12m
96 cm
10m
SCALE: 1M ↔
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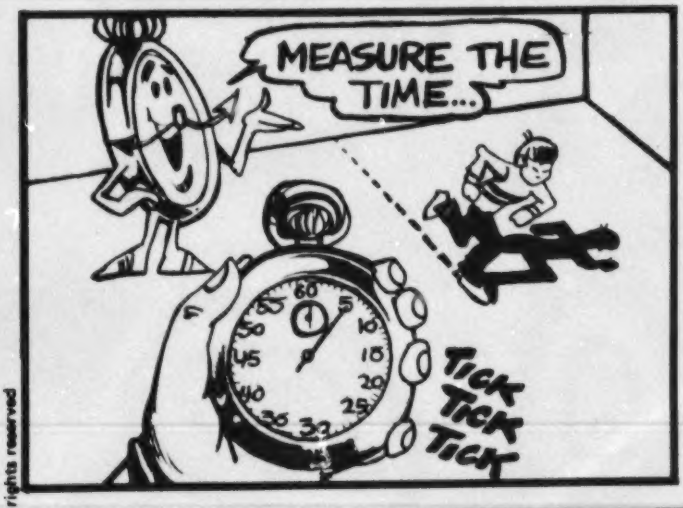
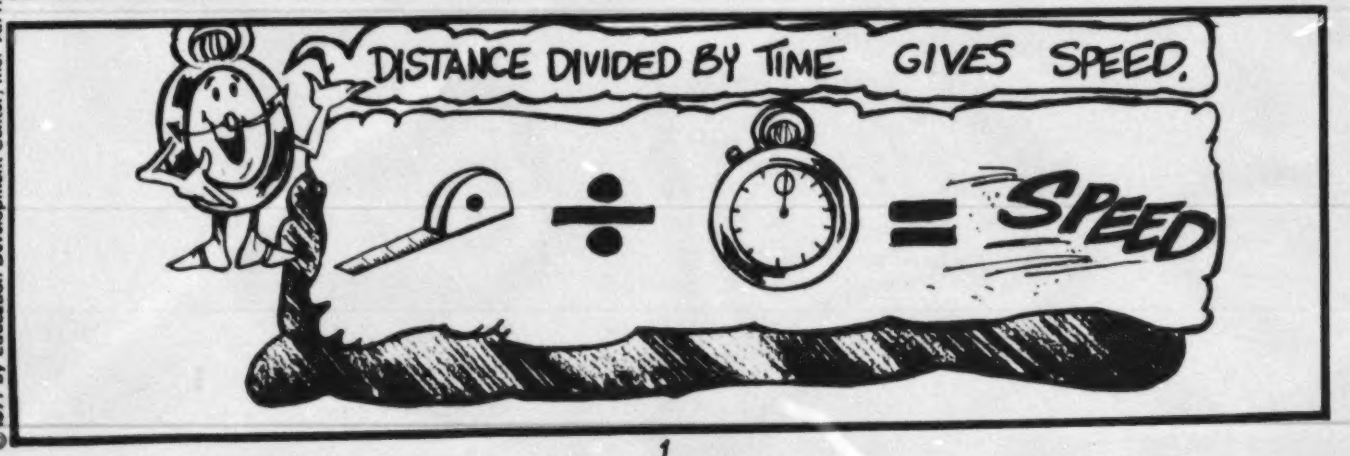
HOW TO

# FIND THE SPEED OF THINGS



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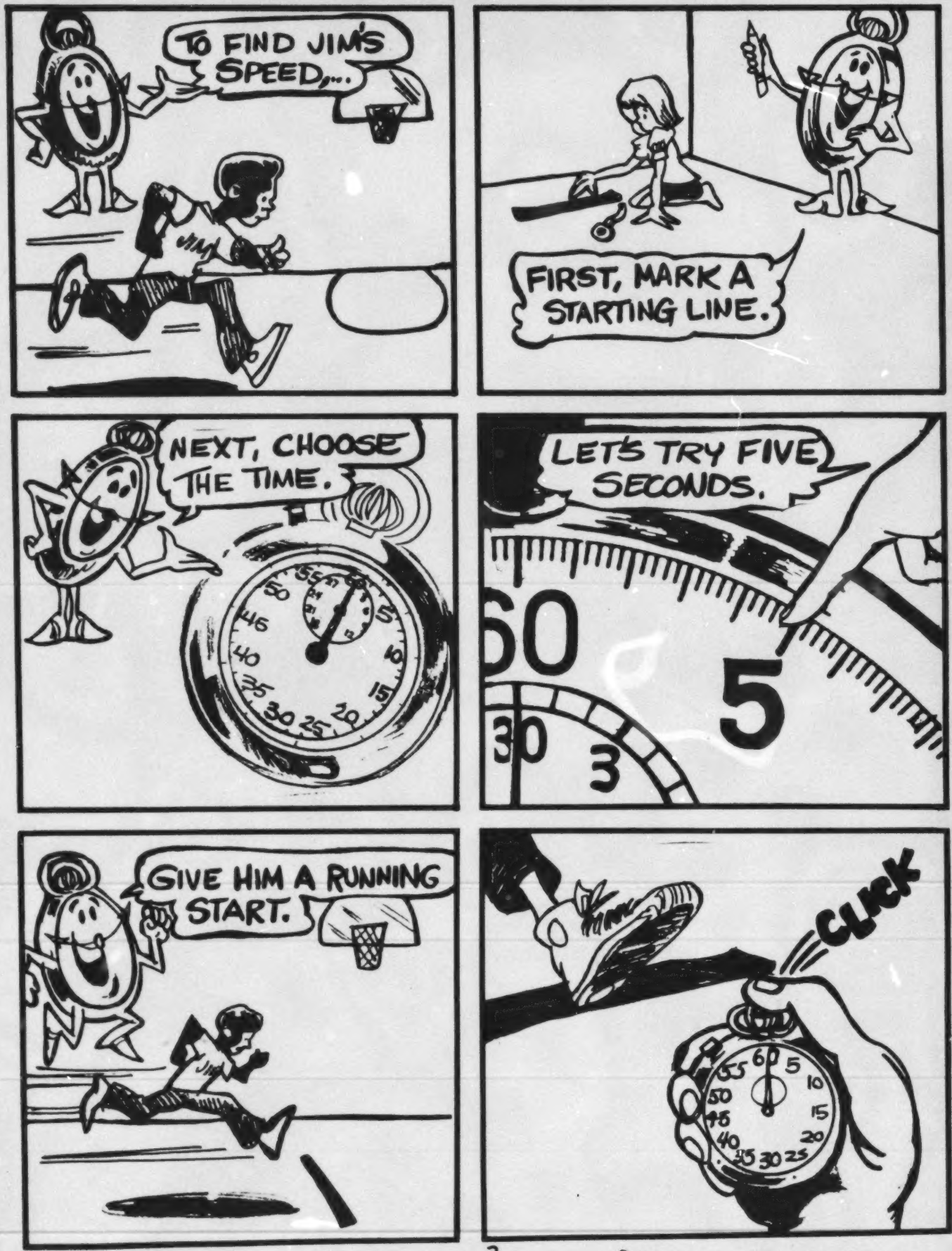
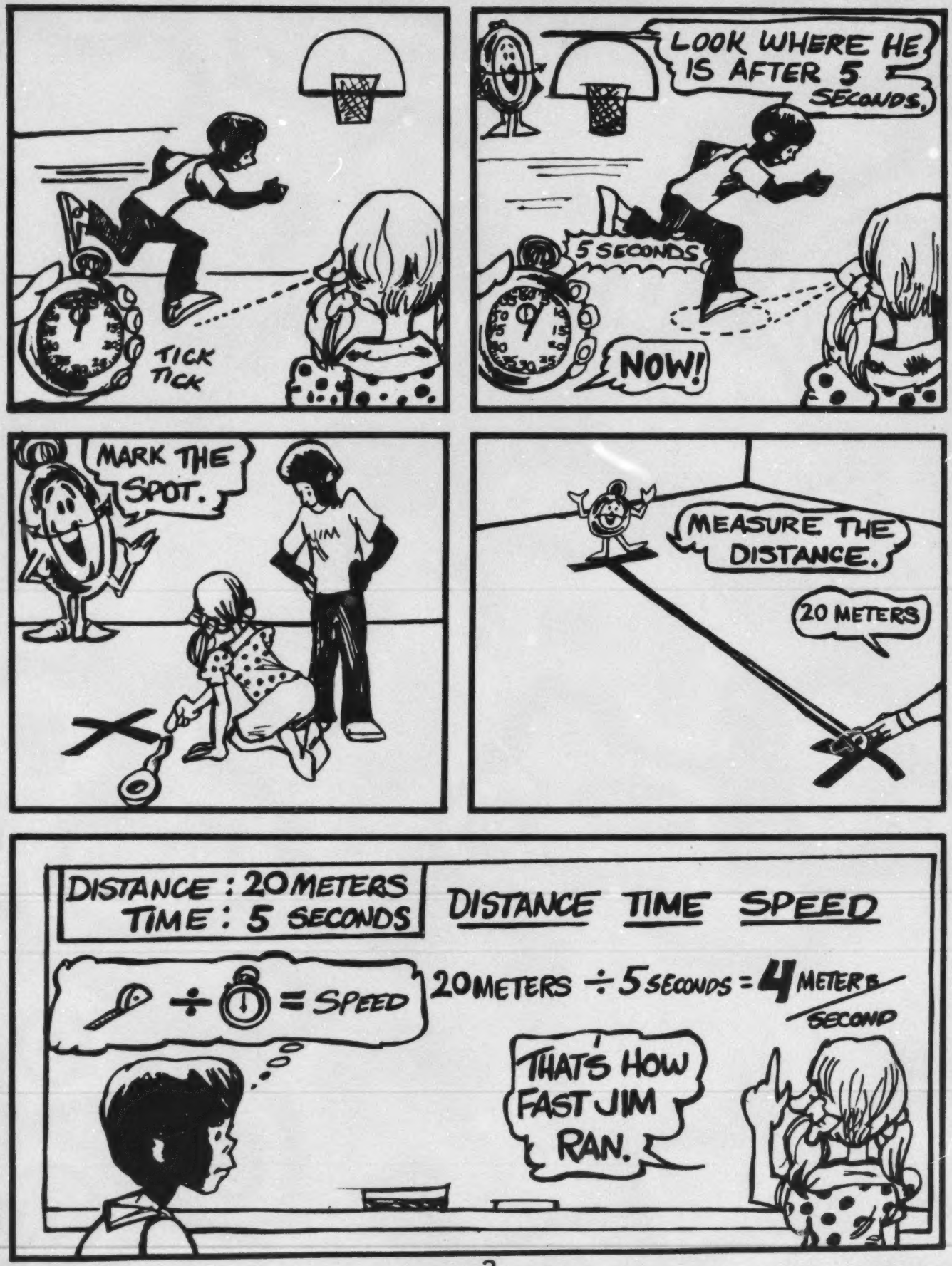
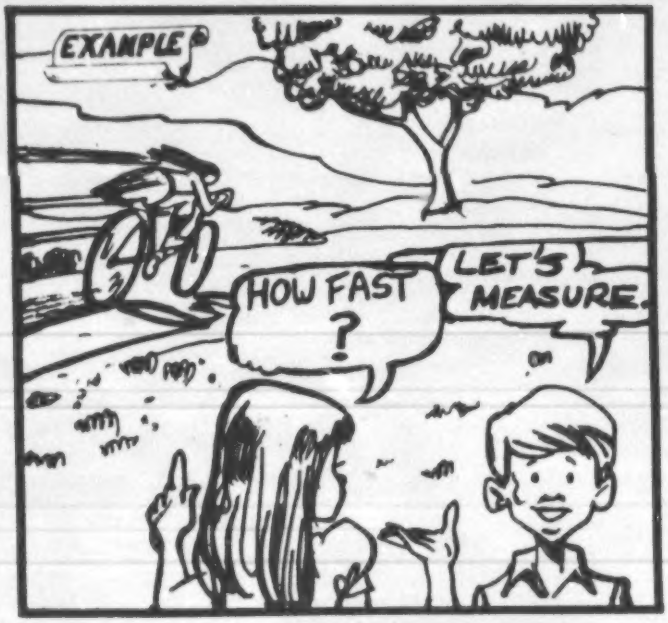
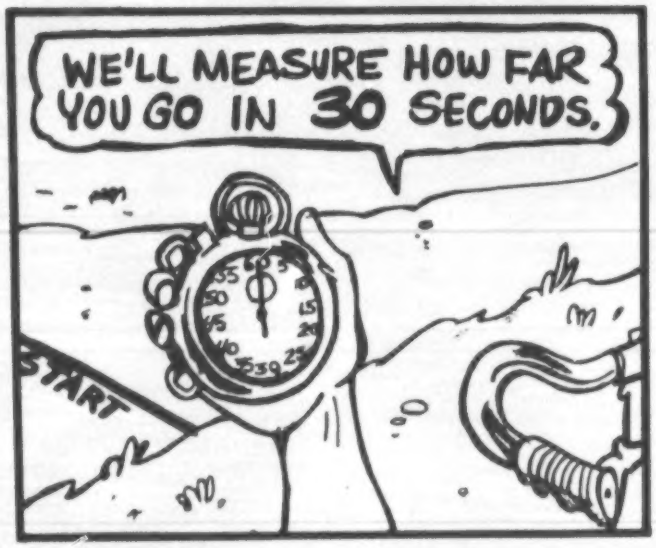

TO FIND JIM'S SPEED,...
FIRST, MARK A STARTING LINE.
NEXT, CHOOSE THE TIME.
LET'S TRY FIVE SECONDS.
60
5
30
3
GIVE HIM A RUNNING START.
CLICK


TICK
TICK
LOOK WHERE HE IS AFTER 5 SECONDS.
5 SECONDS
NOW!
MARK THE SPOT.
JIM
MEASURE THE DISTANCE.
20 METERS
DISTANCE : 20 METERS
TIME : 5 SECONDS
DISTANCE TIME SPEED
÷ = SPEED
20 METERS ÷ 5 SECONDS = 4 METERS/SECOND
THAT'S HOW FAST JIM RAN.


EXAMPLE
HOW FAST ?
LET'S MEASURE.

I'LL MAKE A STARTING LINE HERE.
START


WE'LL MEASURE HOW FAR YOU GO IN 30 SECONDS.
START

CLICK

TICK
TICK TICK

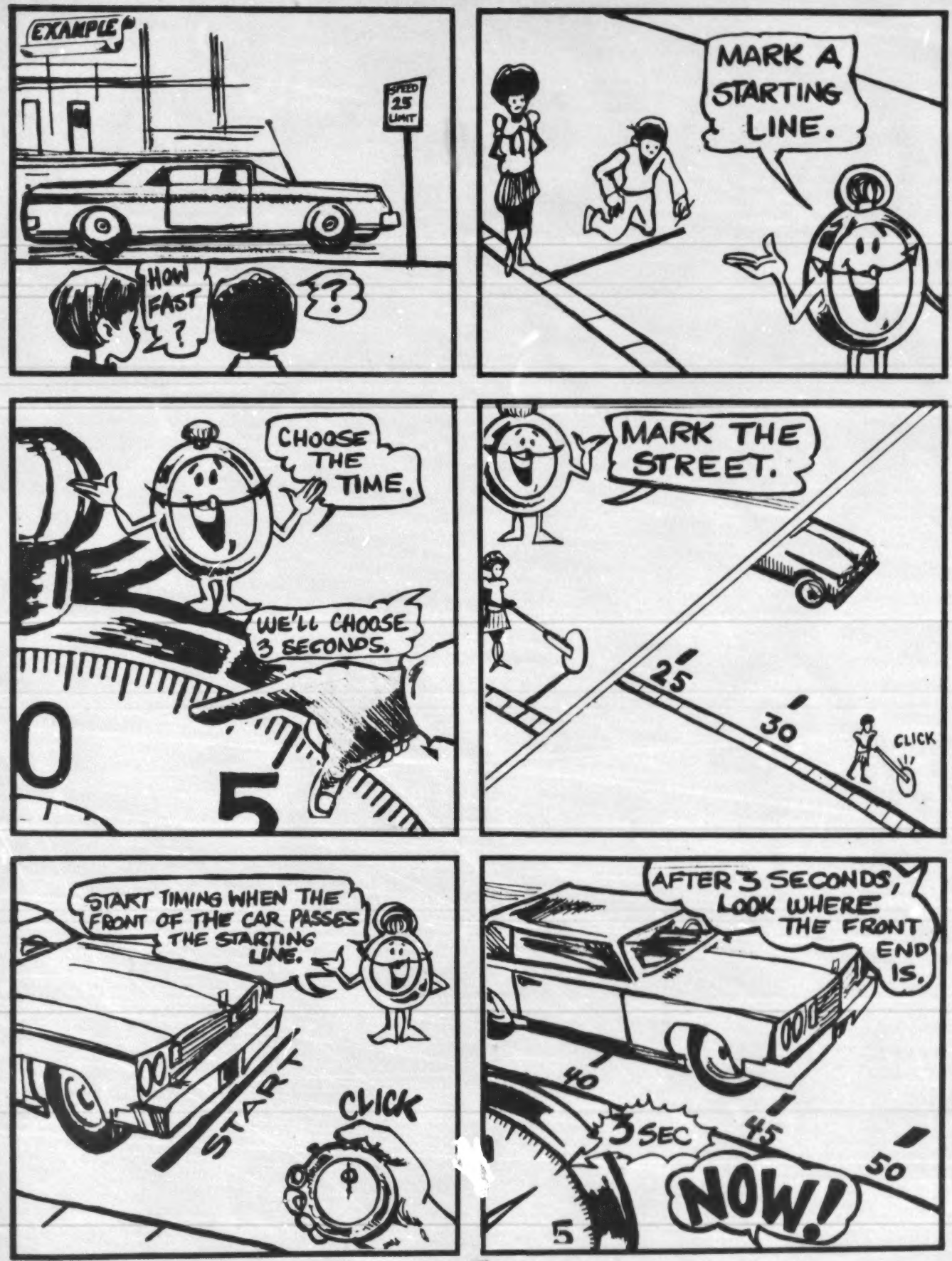
SHE'S OUT OF SIGHT!

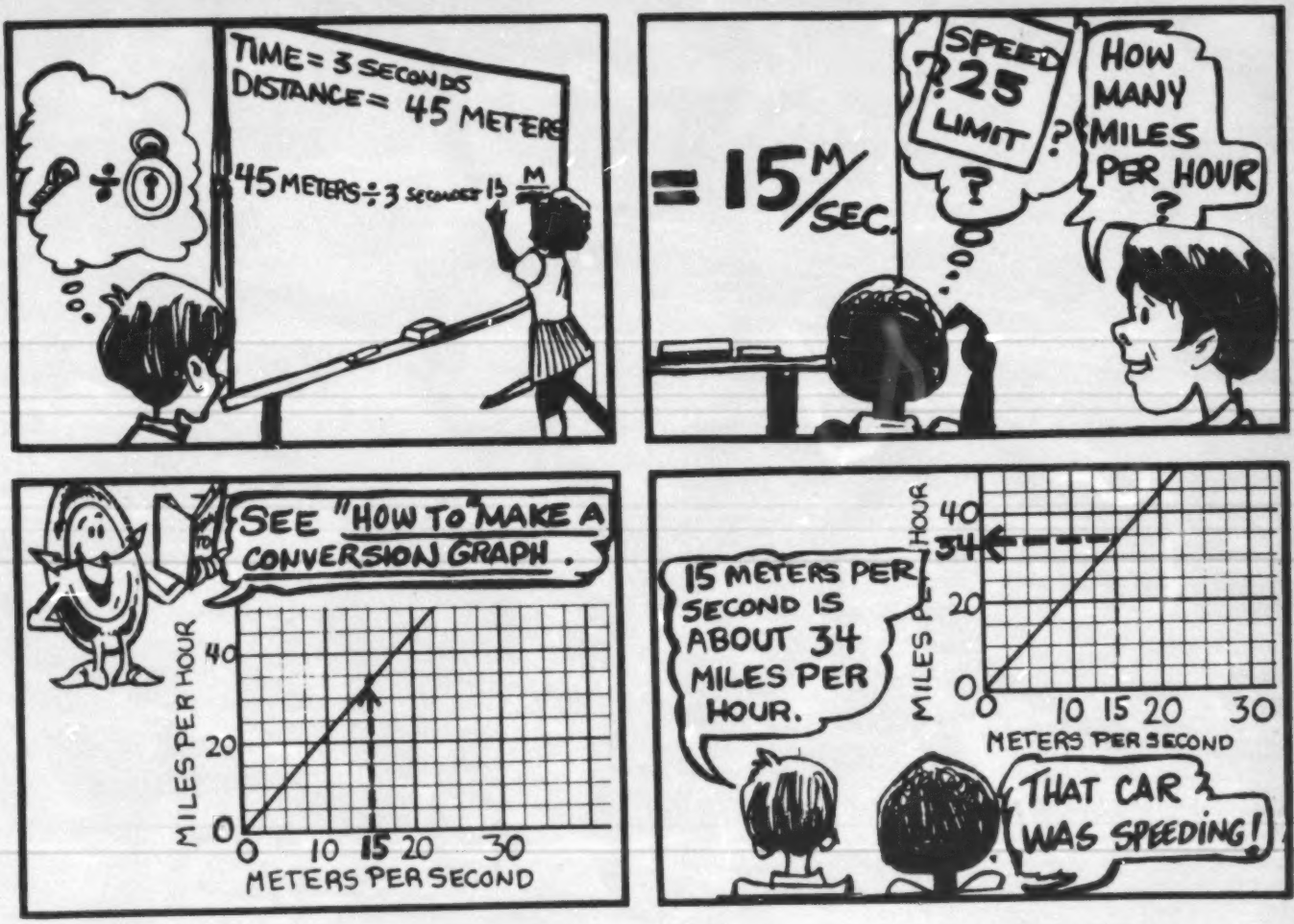
30 SECONDS IS TOO LONG.
30

MAKE A TEST TO PICK A GOOD TIME.
?

FIRST, PICK AN END POINT.
RIDE TO THE TREE.
START
SECOND, MEASURE THE TIME.
12 SECONDS
START
CLICK
LET'S USE 10 SECONDS FOR OUR TEST.
NOW YOU ARE READY TO FIND THE SPEED.
START
CLICK
NOW!
MEASURE THE DISTANCE.
START
95 METERS.
DIVIDE THE DISTANCE BY TIME.
YOUR SPEED WAS 9.5 METERS PER SECOND.
95 METERS ÷ 10 SECONDS = 9.5 METERS/SECOND

EXAMPLE
RRRRRRRRR
HOW FAST ?
RRRRR
CLICK
4 SECONDS
NOW!
10 METERS
NOW, HOW DO WE FIND THE SPEED?
DISTANCE
10 METERS
TIME
4 SECONDS
SPEED IS HOW FAR SOMETHING GOES IN A UNIT OF TIME.
YES, LIKE METERS PER SECOND OR MILES PER HOUR.
SO WE SHOULD DIVIDE DISTANCE BY TIME.
10 METERS ÷ 4 SECONDS = 2.5 METERS/SECOND
÷ = SPEED


EXAMPLE
SPEED 25 LIMIT
HOW FAST?
?
MARK A STARTING LINE.
CHOOSE THE TIME.
WE'LL CHOOSE 3 SECONDS.
0
5
MARK THE STREET.
25'
30'
CLICK
START TIMING WHEN THE FRONT OF THE CAR PASSES THE STARTING LINE.
START
CLICK
AFTER 3 SECONDS, LOOK WHERE THE FRONT END IS.
40'
3 SEC
45'
50'
NOW!
5


TIME = 3 SECONDS
DISTANCE = 45 METERS
45 METERS ÷ 3 SECONDS = 15 M/SEC.
= 15 M/SEC.
SPEED LIMIT ?25 ?
HOW MANY MILES PER HOUR ?
SEE "HOW TO MAKE A CONVERSION GRAPH."
MILES PER HOUR
40
20
0
0 10 15 20 30
METERS PER SECOND
15 METERS PER SECOND IS ABOUT 34 MILES PER HOUR.
34
THAT CAR WAS SPEEDING!
EXTRA!
HERE'S ANOTHER WAY TO FIND THE SPEED.
START
CHOOSE A DISTANCE.
50 METERS
START TIMING HERE.
CLICK
STOP TIMING HERE.
2.4 SECONDS
DIVIDE DISTANCE BY TIME TO FIND THE SPEED.
50 METERS ÷ 2.4 SECONDS IS ABOUT 21 METERS/SECOND.
NOW WE KNOW THE SPEED IS ABOUT 21 METERS PER SECOND.

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